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NEWS AND VIEWS

The Geometroidea section of the *Revised Indexed Check-List of the British Lepidoptera* by I. R. P. Heslop, published in this number, brings us to the end of the 'Macrolepidoptera'. The completion of the whole list will be spread over several more numbers and, to save the considerable wait before the publication of the complete Label List, we are arranging to publish the 'Macrolepidoptera' separately and within a fairly short time.

The Macrolepidoptera list will be published in collaboration with Messrs. Watkins & Doncaster, and we hope that it will help to ensure a stable nomenclature for the benefit of the 'ordinary collector'—who is not so much interested in the technicalities of priority as desirous of being able to label his collection and discuss Moths and Butterflies in a code which will be intelligible to others of like interests, and not require drastic and radical overhaul as soon as another list appears.

To this end Mr. Heslop's list has been drawn up, so far as the generic and specific names are concerned, on the pattern of the new edition of South's 'Butterflies and Moths of the British Isles' now in preparation, and after consultation with specialists working in the

British Museum (Natural History). Changes there will be of course—but the collectors of British Lepidoptera will probably continue to consult 'South' for many years to come and will be able to understand each other through the nomenclature used in the present list.

We must emphasize that the arrangement by families is Mr. Heslop's. If this alters from time to time or does not conform to your own ideas it cannot affect its value as a Label List (in any case my experience is that very few collectors use family names in their cabinets) and any such alterations will be made without the irritation associated with the constant changes of generic and specific names so prevalent in the last couple of decades. E.W.C.

AN ALTERNATIVE FOOD-PLANT FOR *ISOPHRICTIS TANACETELLA* SCHRANCK (LEP., GELECHIIDAE) IN BRITAIN

Mr. S. Wakely (1957, *Ent. Rec.*, **69**: 257) recorded a colony of *Isophrictis tanacetella* Schranck feeding in the seed heads of the previously recorded British food-plant, tansy (*Tanacetum vulgare* L.), near Maidstone, Kent. He remarked on the paucity of records of this species. The distribution, from Kent to Devon and Cambridge, quoted by Meyrick (*A Revised Handbook of the British Lepidoptera,* 1928) is probably based largely on unpublished records. Meyrick's arbitrary adjective 'local', applied to almost every species which is not 'common' does not convey much idea of the status of this insect within the area of known distribution. The Eustace Bankes collection in the British Museum (Natural History) contains only the specimens recorded by Bankes from Devon.

On 19th July, 1959, I found *tanacetella* abundantly around sneezewort (*Achillea ptarmica* L.) on Bookham Common, Surrey, and found it again at a field meeting of the South London Entomological and Natural History Society on similar ground on Ashtead Common, Surrey, on 1st August. I failed to find it on Littleworth Common, Esher, Surrey, and know of no further records. It is likely that this species is at present particularly plentiful where it occurs in Britain and will be found more widely when collectors realize that sneezewort is an alternative food-plant. This is already recognized in France (*vide*: Lhomme, 1939 *et seq.*, *Catalogue des Lépidoptères de France et de Belgique,* **2**: 541).

Mr. H. N. Michaelis tells me that he has often looked without success for *tanacetella* in Lancashire. During 1959 I examined an apparently suitable locality near St. Helens, Lancs., where both tansy and sneezewort grow plentifully, and also drew a blank. Doubtless the species is still of a southern distribution as indicated, though probably not as delimited by Meyrick.

4 Vaughan Avenue, R. W. J. Uffen.
London, W.6.

AN EXPERIMENT WITH MOTHS ON THE EFFECTIVENESS OF A MERCURY VAPOUR LIGHT TRAP

By P. J. M. Robinson

Introduction

During the summer of 1953 some experiments were carried out which were aimed at finding the effective radius of a mercury vapour lamp used in a light trap for catching moths.

The method of marking the moths which was used for these experiments was tedious, and it was intended to devise a quicker simpler way in 1954. Unfortunately another collecting commitment prevented this. Since then circumstances have been such that further work could not be undertaken on this subject. For this reason the results, though neither adequate in number nor carried out over sufficiently extensive a range to have exhausted the subject, are published here for information. If discussion ensues, and further work is stimulated, some of the setbacks described here may be avoided.

Location and description of trap

The trap was located in Hampshire at Sandy Down, near Lymington, and a rough sketch map of the locality shown in Figure 1 gives its position in detail.

The trap comprises a drum of 23 ins. diameter surmounted by an inverted cone in a disc exactly as described in *Ent. Gaz.* 1950, **1**: 3-20, except that there is no vaporizer. The illumination is a 125 watt mercury vapour lamp. The drum, which is 23 ins. deep, is mounted on three legs 30 ins. long, so that the mercury vapour source, which is level at its base with the disc, is about 1½ feet above the hedge to which it is adjacent. The ground falls from north to south over the whole area, and this fall, the height of the light, and the height of the south hedge of the road were such that at the time the hedge cast a shadow over the field for a distance of from 20 to 30 yards from the trap.

Methods of working

As explained previously, no vaporizer was in use. On mornings when the experiments were to be carried out moths were taken from the trap and put into a large cage. As soon as possible after this they were taken from the cage and marked with Chinese lacquer in such colours, numbers or shapes of marks sufficient to identify them subsequently and avoid confusion with other releases. They were then placed in pill-boxes in numbers of five or less and kept until evening. After dark the pill-boxes were emptied at various spots, the positions of which were recorded. The following morning the contents of the trap were examined and particulars noted of any marked moths which had returned.

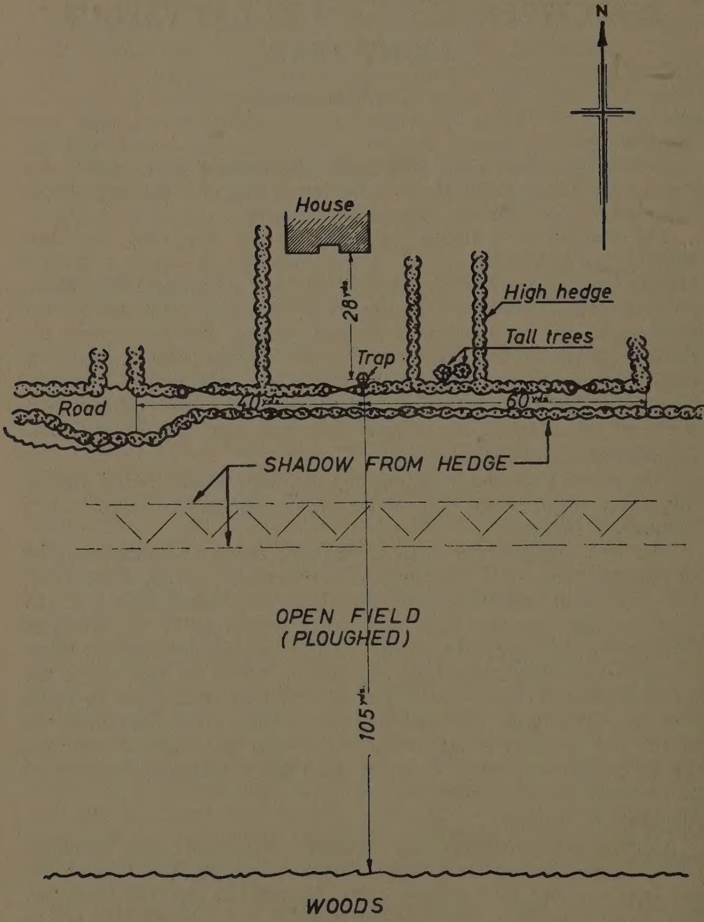

FIG. I DIAGRAM OF DETAILS OF LOCATION OF TRAP.

This method proved satisfactory only for a short period, because of the increasing activity of the moths in the pill-boxes in the evening as the weather became warmer. After three experiments tetrachlorethane was employed as an anæsthetic on 22nd June, but this did not seem the proper solution since some of the moths were more severely affected by it than others. After this date anæsthetic was not used again, but fewer sets of moths were released, and large cages used for containers instead of pill-boxes.

This method proved quite satisfactory except that some individuals seemed less lively than others of the same species. Since there was no way of telling how long the individuals had been emerged, and whether they might even fly no more from where they were liberated, the method finally adopted from 19th July was to place all the moths in one cage which was left opened at the spot to be tried. The opening was placed facing horizontally at right angles to the line joining the trap and the cage. This meant that the door was not pointing towards the light, and insects emerging from the cage were not directed initially towards the light, but at right angles to its rays. Any moths which did not fly at all remained in the cage, and could be noted the following morning. In this way the number escaped can be recorded. In the title of column three in Table 1 of the results, therefore, 'Number liberated or escaped', 'liberated' refers to insects in experiments up to and including No. 8 on 5th July, since they were emptied from the pill-boxes or cages on to the ground, and 'escaped' refers to those in subsequent experiments, which were gone on the following morning from the cages in which they were left. This method was confined to one species *Arctia caja* (L.), since at this time the activity of the moths became such as to give rise to the tedium in marking them distinctly, referred to earlier. In this respect *A. caja* is ideal, as it usually appears in numbers in the trap and is very docile in the heat of the day.

Any operation carried out to the north of the trap, if at a greater distance from the trap than the house, would be alongside the house, to the east or west it would be on the south side of the road, and to the south would be in the open field.

Because of the position of the house no releases were made more than 30 yards north of the trap. Because of the two tall trees and the high hedge to the east of the trap there is a good deal of shadow cast on the road, so that no releases were made to the east.

Results

The results are recorded in Table 1.

Discussion of results

The experiments were aimed at establishing the effective area of operation of a mercury vapour lamp and trap. Reasons, apart from the insufficient number of experiments carried out, that these results do not establish this are:

(i) The insects employed are a selected sample. It is only those insects which have already been caught in the trap which were used. It is possible that they may be congenitally more susceptible to being affected by the light used than others and thus do not behave in the same way as a more general sample would.

(ii) A number of bats fly continuously in the vicinity of the light during the summer months. Three at least have been distinguished as present at the same time. How many of the insects that would be caught by the trap are caught by the bats on the way in has not been established.

(iii) The age of the insects used may affect their behaviour and some may be too old even to get to the trap, while others may be affected in a way to make their behaviour different from that exhibited earlier in their life.

(iv) It is possible also that the paint on the insects' wings might make them less able to fly to the trap or less nimble and so more susceptible to being caught by the bats.

It might be possible to eliminate a number of the objections to the results obtained here and to avoid these effects by allowing bred specimens to emerge at fixed distances from a trap, in a locality where confusion of specimens with indigenous insects will not occur, and where the trap has not been run for a long enough period that bats are encouraged to establish their hunting grounds.

It is still interesting to examine the results obtained, bearing the above limitations in mind.

The total figures are 373 moths released within a radius of 100 yards from the trap, 50 or 13.15 per cent. being recaptured on the night of release. The extremes of variation are from 66.6 per cent. to 0 per cent. This does not give quite a true general picture however, since it seems that there is a difference in behaviour among the different species, the example of 66.6 per cent. being given by *A. caja* L., above.

Does distance make a difference?

There is no doubt, even on the few results obtained, that the effectiveness of the trap falls off with distance. Plotted in Fig. 2 above the horizontal line is the total numbers of moths returning. Below the line a curve is drawn showing the theoretical percentage of insects that should be taken if it is assumed that they all fly radially outwards from the point at which they are liberated, and that those that come within a certain distance of the light are taken. This curve has been fitted to pass through the actual value obtained in the experiment at the 30-yard distance since this figure was obtained from the largest number of results. The curve, which has quite a similar shape to the one obtained by assuming the effect of the light on the insects to be inversely proportional to the square of their distance from it (also plotted and fitted to the experimental

Table 1. TABLE OF INSECTS RETURNING TO TRAP AFTER RELEASE AT VARIOUS DISTANCES FROM IT

No. of Experiment	Date, time weather moon	No. liberated or escaped	Species	Marking	Distance yds and direction from trap	No. returned in trap			Remarks
						1st day	2nd day	3rd day	
1	Sun. 14th June, 11 p.m. S. wind 10/15 m.p.h. Dark, sky overcast.	5	*S. lubricipeda*. L.	R. wing green	15 N.	2			All lively.
		5	*S. lubricipeda*. L.	L. wing green	30 N.	2			
		5	*M. trigrammica*. Hufn.	R. wing yellow	15 N.	2			
		5	*M. trigrammica*. Hufn.	L. wing yellow	30 N.	2			
2	Mon. 15th June, 11 p.m. No wind. Dark, sky overcast.	5	*S. lubricipeda*. L.	R. wing red dot	10 W.	1			
		5	*S. lubricipeda*. L.	L. wing red dot	20 W.	1	1		
		5	*M. trigrammica*. Hufn.	L. wing red dot	10 W.	—			
		4	*M. trigrammica*. Hufn.	L. wing red dot	20 W.	—			
		5	*A. exclamationis*. L.	R. wing red dot	10 W.	3			
		5	*A. exclamationis*. L.	L. wing red dot	20 W.	2			
		5	*A. exclamationis*. L.	Both wings red dot	30 W.	1			
		5	*A. exclamationis*. L.	Both wings red stripes	40 W.	2	1		
3	Tues. 16th June, 11 p.m. SW wind 5 m.p.h. Dark, 50% overcast.	5	*S. lubricipeda*. L.	Black dot right wing	25 S.	—			One returned 21st.
		5	*S. lubricipeda*. L.	Black dot left wing	50 S.	2			
4	Mon. 22nd June, 11 p.m. No wind. No moon. Sky overcast.	5	*S. lubricipeda*. L.	Black spot R. wing	80 S.	—			Some not very happy. Used tetrachlorethane as anaesthetic except for *elpenor*.
		4	*S. lubricipeda*. L.	Black spot L. wing	100 S.	—		1	
		5	*S. lutea*. Hufn.	Black spot R. wing	80 S.	—			
		2	*A. exclamationis*. L.	Black spot R. wing	10 S.	—			
		5	*A. exclamationis*. L.	Black spot L. wing	80 S.	—			
		4	*A. exclamationis*. L.	Black spot both W.	50 S.	—			
		5	*A. exclamationis*. L.	Black spot R. shoulder	70 S.	—			
		4	*A. exclamationis*. L.	Black spot L. shoulder	30 S.	—			
		2	*A. exclamationis*. L.	Black spot both sh.	60 S.	—			
		5	*A. exclamationis*. L.	Black bar R. wing	40 S.	—			
		2	*A. exclamationis*. L.	Black bar L. wing	20 S.	—			
		6	*D. elpenor*. L.	Black spot R. wing	80 S.	1			

Table 1. *Continued*

5	Tues. 23rd June, 11 p.m. No wind. ½ moon, sky clear, warm.	5	*S. lubricipeda*. L.	Red dot R. wing	80 S.	—			All lively.
		5	*S. lubricipeda*. L.	Red dot L. wing	40 S.	—			
		4	*S. lubricipeda*. L.	Red dot both W.	60 S.	—	1		
		4	*M. trigrammica*. Hufn.	Red dot R. wing	80 S.	1			
		5	*A. exclamationis*. L.	Cream dot R. wing	40 S.	—			
		5	*A. exclamationis*. L.	Red dot L. wing	80 S.	—		1	
		5	*A. exclamationis*. L.	Red dot both W.	40 S.	—			
		6	*A. exclamationis*. L.	Red bar R. wing	60 S.	—			
		5	*S. lutea*. Hufn.	Red dot R. wing	40 S.	—			
		4	*S. lutea*. Hufn.	Red dot L. wing	80 S.	—			
		3	*P. bucephala*. L.	Red dot R. wing	80 S.	—	1		
6	Sat. 27th June, 11 p.m. Wind v. variable. 0/15 m.p.h. all points. Full moon, sky clear, warm.	5	*S. lubricipeda*. L.	Green dot R. wing	60 W.	1			Very lively.
		5	*A. monoglypha*. Hufn.	Green dot R. wing	60 W.	1			
		5	*P. bucephala*. L.	Green dot R. wing	60 W.	2			
		3	*T. pronuba*. L.	Green dot R. wing	60 W.	—			
		2	*B. betularia*. L.	Green dots both W.	60 W.	—			
		5	*A. exclamationis*. L.	Green dot R. wing	60 W.	—			
		4	*A. exclamationis*. L.	Green dot L. wing	50 W.	—			
		4	*A. exclamationis*. L.	Green dot both W.	40 W.	—	1		
		5	*A. exclamationis*. L.	Green dot R. shoulder	40 S.	1			
		5	*A. exclamationis*. L.	Green dot L. shoulder	50 S.	—	One returned 4th July.		
		5	*A. exclamationis*. L.	Green dot both sh.	60 S.	—			
		5	*A. exclamationis*. L.	Green bar R. wing	60 S.	—			
7	Sun. 28th June, 11 p.m. Wind 0/15 m.p.h. NW. Gusty, sky overcast.	1	*S. ligustri* L.	Blue on R. wing	50 W.	—			All placed in one large container & liberated together.
		3	*D. elpenor*. L.	Blue on R. wing	50 W.	—	One returned 4th July.		
		5	*A. monoglypha*. Hufn.	Blue on R. wing	50 W.	—			
		1	*H. pinastri*. L.	Blue on R. wing	50 W.	—			
		5	*L. varia*. Vill.	Blue on R. wing	50 W.	—			
		3	*S. lubricipeda*. L.	Blue on R. wing	50 W.	—			
		5	*A. exclamationis*. L.	Blue on R. wing	50 W.	—			
		6	*T. pronuba*. L.	Blue on R. wing	50 W.	—			One escaped prematurely.
		2	*B. betularia*. L.	Blue on R. wing	50 W.	—			
		2	*S. lutea*. Hufn.	Blue on R. wing	50 W.	—			

Table 1. *Continued*

8	Sun. 5th July, 10.45 p.m. No wind. Sky clear, no moon.	2	*D. elpenor*. L.	R. wing	30 W.	—		Colour and type of marking not recorded at the time.
		1	*O. sambucaria*. L.	R. wing	30 W.	—		
		2	*L. populi*. L.	R. wing	30 W.	—		
		4	*A. exclamationis* L.	R. wing	30 W.	—	1	
		1	*B. betularia*. L.	R. wing	30 W.	—		
		1	*P. bucephala*. L.	R. wing	30 W.	—		
		2	*T. pronuba*. L.	R. wing	30 W.	—		
		2	*L. varia*. Vill.	R. wing	30 W.	—		
		2	*P. gamma*. L.	R. wing	30 W.	—		
		2	*S. lubricipeda*. L.	R. wing	30 W.	—		
		1	*C. repandata*. L.	R. wing	30 W.	—		
		2	*D. oleracea*. L.	R. wing	30 W.	—		
		2	*L. pallens*. L.	R. wing	30 W.	—		
		2	*A. monoglypha*. Hufn.	R. wing	30 W.	—		
		1	*L. lithargyria*. Esp.	R. wing	30 W.	—		
		2	*D. elpenor*. L.	both W.	60 W.	—		
		1	*O. sambucaria*. L.	both W.	60 W.	—		
		2	*L. populi*. L.	both W.	60 W.	—		
		4	*A. exclamationis*. L.	both W.	60 W.	—		
		1	*B. betularia*. L.	both W.	60 W.	—		
		2	*P. bucephala*. L.	both W.	60 W.	—		
		2	*T. pronuba*. L.	both W.	60 W.	—		
		2	*L. varia*. Vill.	both W.	60 W.	—		
		2	*P. gamma*. L.	both W.	60 W.	—		
		2	*S. lubricipeda*. L.	both W.	60 W.	—		
		3	*C. repandata*. L.	both W.	60 W.	—		
		2	*D. oleracea*. L.	both W.	60 W.	—		
		2	*L. pallens*. L.	both W.	60 W.	—		
		2	*A. monoglypha*. Hufn.	both W.	60 W.	—		
		1	*L. lithargyria*. Esp.	both W.	60 W.	—		

Table 1. *Continued*

9	Sun. 19th July, 11 p.m. Wind S/SW, 10/15 m.p.h. Raining.	9	*A. caja*. L.	Blue R. wing	30 N.	1	3	12 exposed in cage.
10	Mon. 20th July, 11 p.m. Wind S, 5 m.p.h. ½ moon, low down.	9	*A. caja*. L.	Green R. wing	30 N.	4	1	1 returned 24th July. 11 exposed in cage. One blue marked in cage in morning.
11	Tues. 21st July, 11 p.m. Wind SW, 15/20 m.p.h. ½ moon, 50% masked.	7	*A. caja*. L.	Pink R. wing	30 N.	2		One of this marking dropped from the beak of a bird disturbed by visit to trap.
12	Thurs. 23rd July, 11 p.m. No wind. ¾ moon, sky clear	12	*A. caja*. L.	Blue both wings	30 N.	1		One returned 28th July. 13 exposed in cage.
13	Sun. 2nd Aug., 11 p.m. No wind. No moon, no cloud.	5	*A. caja*. L.	Blue R. wing	30 N.	2	2	
14	Wed. 5th Aug., 11 p.m. Wind SW, 5 m.p.h. No moon, sky clear.	8	*A. caja*. L.	Green R. wing	30 W.	6		10 exposed in cage.
15	Thurs. 6th Aug., 11 p.m. No wind. No moon, sky clear, warm.	10	*A. caja*. L.	Pink R. wing	40 W.	7		12 exposed in cage. Slight anaesthetic in trap.

results at 30 yards) does not fit well with the results obtained. The latter seem too low at the extremes of distance, and this might, if it is valid, indicate that the repulsive effect referred to in earlier papers does in fact exist.

It is of interest that the radius of effectiveness of the light which makes the theoretical curve fit the value obtained at the distance of 30 yards, and which since it envelops most of the results may be an optimistic estimate, is 18.82 yards. In other words, if the action is that the insects fly in random radial directions, only those being trapped which fly to within a certain distance of the light, it would appear that they must approach to within 18.82 yards of the light to be so.

Does the species make a difference?

Comparing the results of two species in Figure 3 indicates that there may well be some difference in the effect of the light on *S. lubricipeda* L., and *A. exclamationis* L. When plotted as a percentage the curve for the former is flatter, extending to a greater distance from the trap. The curve for *S. lubricipeda* follows fairly well the average line for all the experiments but that for *A. exclamationis* does not.

Does direction make a difference?

It certainly looks in Figure 4 as though the number of insects returning from short distances to the south is lower than in the other directions. Of 13 released within 30 yards none returned. Since there does not appear to be much difference between the results for north and west of the trap it is not unreasonable to assume that this could be due to the effect of the shadow cast by the hedge, shown in Fig. 1.

Conclusions

1. It would appear that the effective radius of a 125 watt mercury vapour lamp used in the type of trap described may well be not more than 20 yards.
2. There may be justification for thinking that different species are affected by the light in different ways. There may be some repulsive effect due to the light.
3. Obstructions to the light may well have an adverse effect on the performance when using a trap of this nature, and it should therefore be set up as far as possible in the open.
4. The results obtained here are not exhaustive. They could be amplified more easily if a better method of marking the insect could be used, and they could be checked by using emerging insects in localities where identification and the minimum of loss could be ensured.

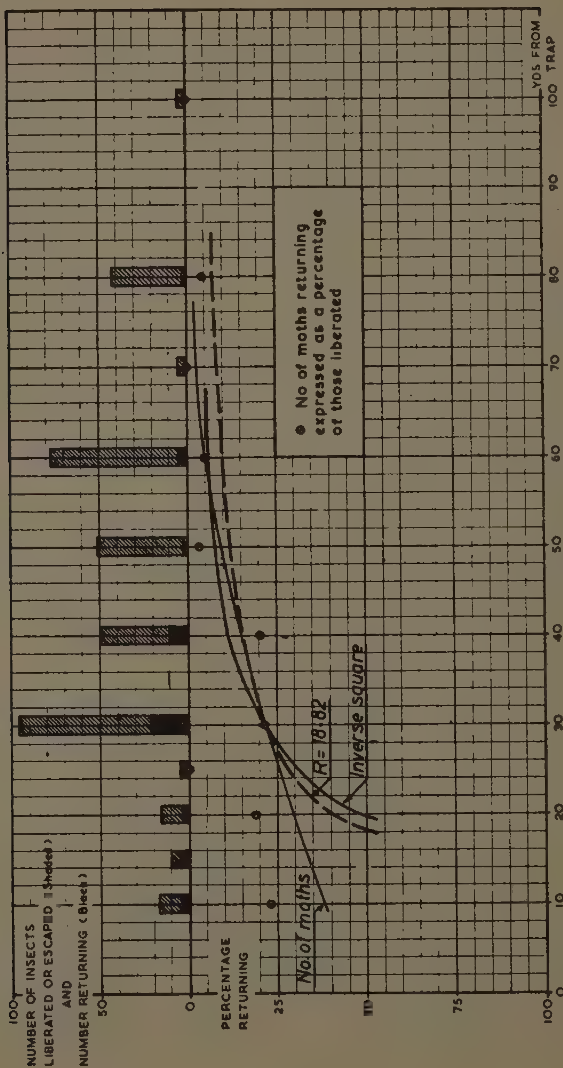

FIG. 2 TOTAL INSECTS RELEASED AND RETURNING.

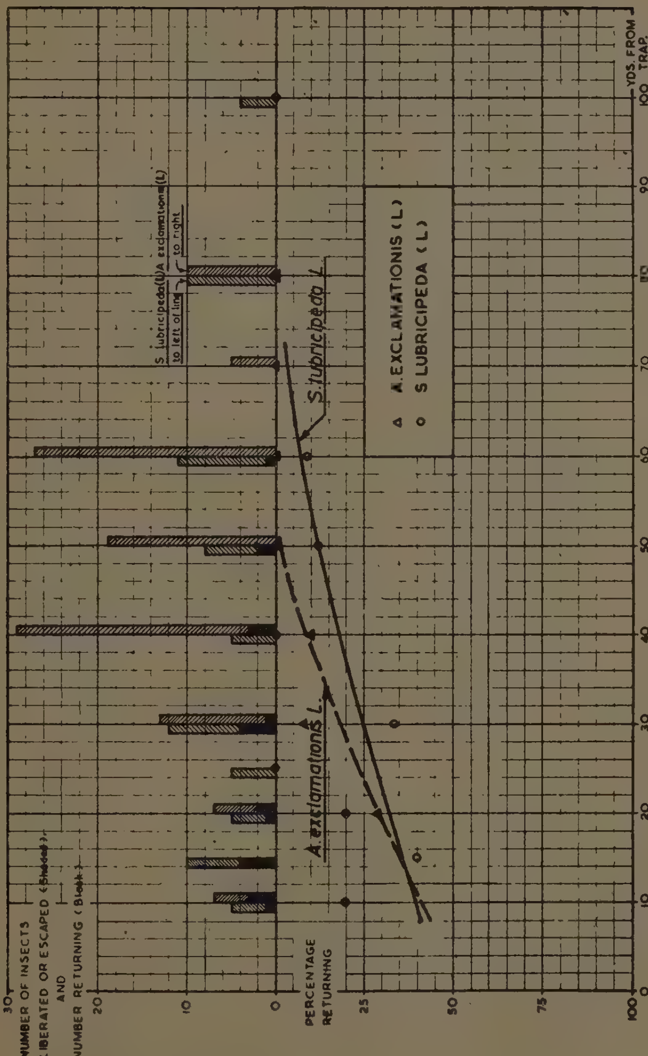

FIG. 3 COMPARISON OF RESULTS OF TWO SPECIES

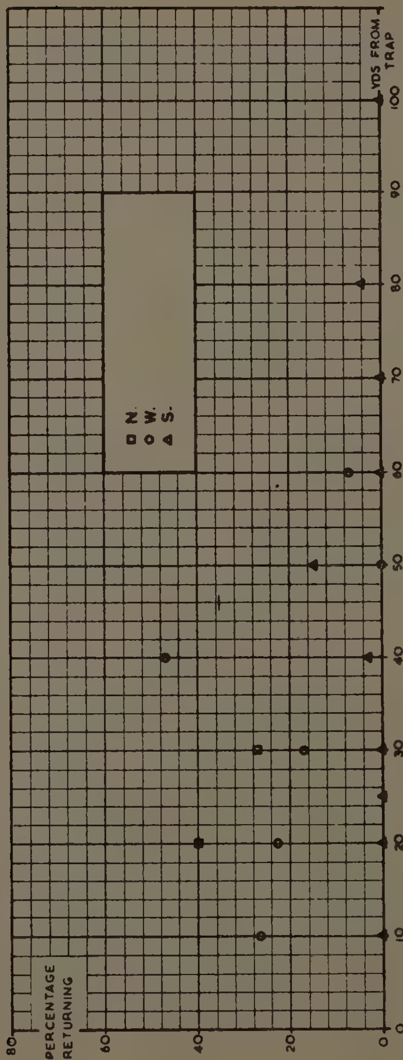

FIG 4 PERCENT RETURNING TO TRAP ACCORDING TO DIRECTION AND DISTANCE OF RELEASE

SOME FACTORS THAT AFFECT THE ABUNDANCE OF THE WINTER MOTH, *OPEROPHTERA BRUMATA* (L.) (LEP., GEOMETRIDAE) IN WESTERN EUROPE

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INTRODUCTION

In Western Europe the winter moth, *Operophtera brumata* (L.) (Lep., Geometridae), commonly defoliates fruit and deciduous forest trees on which no artificial control measures are applied. Information on factors that affect its abundance was obtained from investigations in several localities in Europe (for details of the localities see Wylie, in preparation) and from laboratory studies in Canada with imported material. These factors and others recorded in the literature are discussed below.

ACKNOWLEDGEMENTS

Thanks are extended to Dr. H. E. Welch, Belleville, who directed investigations in Europe in 1954 and collaborated with the author in Europe in 1955; to Mr. J. H. McLeod, Belleville, who directed European investigations in 1956; and to the numerous European organizations and individuals, cited in another publication (Wylie, in preparation), who greatly facilitated the collections in Europe. Thanks are extended also to Dr. R. Gaumont, Institut National Agronomique, Paris, France, for a French translation of the publication by Dr. I. V. Kozhanchikov, to Dr. Blenkendorff, Deutsche Wetterdienst, Frankfurt, Germany, for information on weather conditions in Germany, and to Mr. A. R. Graham and Mr. G. E. Maybee for assistance with the rearing work at Belleville.

CLIMATIC FACTORS

(a) Temperature

(i) *Effect on Adults.* Adult mortality in western Europe caused by low temperature is probably negligible, as moths from Oldenburg, Germany, survived exposure to –12 deg. C. for five days, though the mean minimum temperatures, recorded by the German Weather Service, for November, December and January in this locality are –5.3 deg. C., –8.2 deg. C., and –10.5 deg. C. Tests showed that the temperature thresholds for emergence and mating for adults from Oldenburg, and from Versailles, France, and Oland, Sweden, were approximately O deg. C., and that females would mate within an hour of emergence; therefore, temperature is not usually low enough to prevent mating if males are present. Furthermore, oviposition, which occurred above approximately O deg. C., commenced within 48 hours of copulation. Tests also showed that if the temperature remained above O deg. C. a female laid most of her eggs within

48 hours of the onset of oviposition. Brief periods of frost are, however, common during the emergence period (Thiem, 1922; Grison and Silvestre de Sacy, 1948) and probably increase the percentage of females killed, either by various invertebrate predators (Jary, 1931) or birds (Betts, 1956), before they finish laying. Both sexes are able to mate and females to lay after temporary exposure to temperatures below O deg. C.: moths from Versailles and Oldenburg that had been at –12 deg. C. for five days became active again at 1.5 deg. C. and copulated, and mated females that had been at –4.5 deg. C. for five days laid as many fertile eggs at 6.5 deg. C. as those held continuously at the latter temperature. However, temperatures below –4.5 deg. C. reduced the proportion of fertile eggs, and mated females that were at –12 deg. C. for five days and then were at 6.5 deg. C. laid only sterile eggs.

It is unlikely that there are strains of *O. brumata* in northern Europe that reproduce at lower temperatures, because the temperature thresholds for emergence and oviposition at Leningrad, U.S.S.R., recorded by Kozhanchikov (1950) are approximately the same as those recorded at more southern latitudes in the present study. The absence of the winter moth from extreme north-eastern Europe and the adjacent region of Asia is, according to Kozhanchikov, the result of the earlier and more abrupt onset of winter that inhibits emergence and egg laying, and of very low temperatures in winter that prevent egg survival.

(ii) *Effect on Eggs*. Usually, temperature is not sufficiently low to kill many eggs. For example, though the German Weather Service reports a mean minimum temperature of –10.5 deg. C. during the period of egg development at Oldenburg, over 70 per cent of freshly-laid eggs from this locality survived exposure to –12 deg. C. for 28 days. Tests with lots of approximately 125 freshly-laid eggs from Versailles gave similar results (Table 1); eggs used in these tests were held at 6.5 deg. C. until larvae hatched. Though detailed temperature data for the latter locality are unavailable, the mean temperature during egg incubation is about 2 deg. C. (Grison and Silvestre de Sacy, 1948), and the minimum annual temperature probably does not differ greatly from that at Oldenburg.

Tem. deg. C. to which eggs exposed	Continuously	Per cent hatch after eggs exposed 112 days	84 days	56 days	28 days	14 days	7 days
6.5	92	—	—	—	—	—	—
1.5	0	94	—	—	—	—	—
–4.5	0	55	65	68	77	—	—
–12.0	0	22	56	60	90	83	96
–16.0	0	0	23	44	72	85	93

Table I. Effect of low temperature on survival of freshly-laid winter moth eggs from Versailles, France.

These numerical results cannot be applied directly to survival in nature, where temperature and factors that moderate it are not con-

stant. However, it is probable that egg mortality caused directly by low temperature is negligible at Versailles and in most localities in Europe, with the exception of those near the northern and eastern limits of the range of the species.

Kozhanchikov (1950) showed that, near Leningrad, temperatures below 0 deg. C. in winter broke egg diapause and permitted further embryological development. This does not apply throughout the range of the species in Europe because there was low mortality of eggs from Versailles, from Oldenburg and Frankfurt, Germany, and from Oland and Kullaberg, Sweden, that were incubated continuously at 6.5 deg. C. or at higher temperatures up to 18 deg. C.

(iii) *Effect on Larvae.* Varley and Gradwell (1958) showed that freshly-hatched larvae that failed to find open or partially-open buds, spun silken threads and were often carried short distances by the wind. They also concluded from field studies that mortality among these larvae was higher than among those not dispersing, presumably because many of them failed to find trees that contained suitable food. Tests in the present study showed that first instar caterpillars from Versailles lived up to two weeks without food at 1.5 deg. C., seven to ten days at 6.5 deg. C., and only two or three days at 18 deg. C.; therefore, low temperature at this time influences the possibility that a larva will survive until suitable food is available. The extent to which climatic factors affect synchronization of larval hatch and bud opening, and therefore larval survival, was not investigated.

That larval mortality caused directly by low temperature is usually negligible is indicated by survival of first instar larvae for up to two weeks at 1.5 deg. C., and by the conclusions of Schneider-Orelli (1915) that few larvae were killed by frost, and of Feytaud (1928) that they survived exposures to −17 deg. C. There are also no reports that high temperature in nature causes high larval mortality. As environmental temperature increases during larval development, its effect is probably not the same on each instar; therefore the report of Kozhanchikov (1950) that 25 deg. C. killed many larvae is inconclusive because he did not indicate the larval instars tested. However, high temperature during larval development may limit the southern distribution of the species because it adversely affects both larvae and pupae (Kozhanchikov, 1950).

(iv) *Effect on Pupae.* Pupal mortality is directly related to temperature during the preceding larval period (Kozhanchikov, 1950); thus, an unusually high mean temperature in spring can cause a lower moth population in the following autumn.

The optimum temperature for survival decreases in the autumn: thus, though mortality of pupae from Versailles held for 79 days during summer and early autumn at 18 deg. C. was 15 per cent, and of those held at 6.5 deg. C. was 91 per cent, no moths emerged

from cocoons held at 18 deg. C. after 25th October, and a large proportion did so at 6.5 deg. C. High temperature in summer and early autumn probably does not kill many winter moth pupae in most localities; mortality of those from Oldenburg at 24 deg. C. from 7th August until 25th October was less than 25 per cent, though the German Weather Service reports mean temperatures for August, September and October for that locality as approximately 15.9 deg., 13.1 deg. and 8.7 deg. respectively, and mean maxima are 27.9 deg., 24.5 deg. and 19.1 deg. High temperatures late in autumn occasionally delay moth emergence (Faes, Staehelin and Bruderlein, 1924; Paillot, 1934) and may cause mortality. This was investigated by exposing at 18 deg. C. three lots of 300 cocoons each from each of three localities (Oland, Oldenburg and Versailles), and then transferring to 6.5 deg. C. one lot from each locality on 25th September, one on 25th October, and one on 25th November. Moth emergence was recorded, then unemerged cocoons dissected and the number of dead moths and pupae counted. The percentages of both sexes that emerged died as adults before emerging, and died as partly-formed adults are shown in Table II.

	♂ Survival			♀ Survival		
Loc. & date tem. reduced to 6.5° C.	P.C. ♂ emerged	P.C. dead unemerged adults	P.C. dead ♂ pupae	P.C. ♀ emerged	P.C. dead unemerged adults	P.C.dead ♀ pupae
Oland						
25th Sept.	52	26	23	77	20	3
25th Oct.	18	44	38	68	32	0
25th Nov.	5	9	87	48	52	0
Oldenburg						
25th Sept.	88	2	10	97	2	2
25th Oct.	63	6	31	94	6	0
25th Nov.	28	5	68	80	12	8
Versailles						
25th Sept.	53	44	3	66	32	2
25th Oct.	46	43	11	72	25	3
25th Nov.	19	45	35	69	25	6

Table II. Effect of high temperature late in pupal development on winter moth survival.

A delay until 25th November in the onset of lower temperatures reduced emergence of males from all localities and of females from Oland and Oldenburg, but not from Versailles. Increased male mortality was mostly as partly-formed moths, and that of females as fully-formed ones. Pupae from the three localities kept in identical conditions matured in the sequence Oland—Oldenburg—Versailles, and this probably accounts for the effect of high temperature, as the females are not killed at 18 deg. C. until they have matured. The significance of these results in nature is that very warm weather in autumn would increase mortality of male more than that of female pupae unless it persisted after the females had matured. Unfertilized females lay only infertile eggs; however, the effect of increased male

mortality on the egg population of the next generation is partially offset by the fact that each male can fertilize several females.

The data in Table II also show that, apart from any temperature effect, there was relatively more mortality of fully-formed, unemerged moths at Versailles than at Oldenburg or Oland. The reason for this is unknown, but the heavier, denser layer of soil that covered the cocoons from Versailles may have prevented emergence of moths more effectively than in other localities.

Tests confirmed the observation of Thiem (1922) that emergence ceases below approximately O deg. C. and starts again after the temperature rises above this level. Prolonged exposure to temperatures below O deg. C. reduced survival, especially of males: mortality of males held at –4.5 deg. C. was 43 per cent after 23 days and 100 per cent after 49 days, whereas corresponding values for females were 12 and 26 per cent. Mortality of males was both as pupae and unemerged adults and that of females as unemerged adults. There are no records of pupal mortality in the field caused by low temperature, and probably mortality is negligible because pupae are protected in the soil from the effects of temperature fluctuations, and temperatures below O deg. C. usually persist only for a few days at one time during pupal development.

(b) Moisture

Moisture alone is probably not harmful to the moths, but heavy rains and snowfalls cause mechanical injury to the male wings and thereby hinder flight (Faes, Staehelin and Bruderlein, 1924).

The effect of moisture on egg survival is unknown. In nature contact moisture is probably present, especially in spring before the larvae hatch. Survival exceeded 90 per cent at a relative humidity of 80-85 per cent in laboratory tests (Table I).

Heavy rains dislodged many caterpillars from the foliage, resulting in the starvation of those that failed to find suitable food again. Damp soil is preferred for pupation: experimentally, many larvae died if the soil was dry or if they failed to find soil, though in the latter case a small percentage spun very thin, colourless, transparent cocoons and pupated normally. In nature most of the larvae locate a suitable pupation site either by crawling over the ground or by burrowing deeply into dry or sandy soil.

Prolonged drought in summer is unfavourable to immature pupae. This is indicated by survival in two lots each of 150 cocoons from Oldenburg, that were held for 76 days at 18 deg. C. in wet vermiculite and in vermiculite with a relative humidity of 60-65 per cent. They were then kept at 6.5 deg. C. and a relative humidity of 80-85 per cent until the moths emerged. Dissection of the cocoons from which no adults had emerged showed that absence of contact moisture had greatly increased mortality of male but not of female pupae or of unemerged moths of either sex.

Lack of moisture in the soil after the pupae have matured does not prevent moth emergence. This is shown by the equal survival of two lots of 150 cocoons each from Oldenburg that had contact moisture, and a relative humidity of 80-85 per cent from 25th October until moth emergence was completed.

Very wet soil is apparently unfavourable: Thiem (1922) reported that floods from the Vistula River killed many pupae and reduced winter moth abundance locally for several generations.

BIOTIC FACTORS

(a) Insect Parasites

Twenty-six species of insect parasites reared from winter moth in the present study are listed elsewhere (Wylie, in preparation). Twelve species were recorded commonly from a number of localities and the remainder rarely. Of the 12 most common species *Cyzenis albicans* (Fall.) (Dip., Tachinidae) was always the most abundant; its incidence in mature winter moth larvae exceeded 10 per cent in most localities and was 49 per cent at Kullaberg. *Lypha dubia* (Fall.), *Phorocera obscura* (Fall.) (Dip., Tachinidae) and *Agrypon flaveolatum* (Grav.) (Hym., Ichneumonidae) were the next most common species, though each usually caused negligible mortality; *Phobocampe crassiuscula* (Grav.) (Hym., Ichneumonidae) killed approximately three per cent of the host larvae in one collection, but usually was much more scarce; each of six other species: *Campoplex* (= *Eulimneria*) *rufifemur* (Thoms.), *Lissonota biguttata* Holmg., *Netelia latungula* (Thoms.) (Hym., Ichneumonidae), *Apanteles jucundus* Marsh. (Hym., Braconidae), *Eulophus larvarum* (L.) (Hym., Eulophidae), and *Phryxe longicauda* Wainw. (Dip., Tachinidae) did not develop in more than 0.1 per cent of the hosts collected in any one locality; and *Aptesis abdominator* (Grav.) (Hym., Ichneumonidae), which parasitizes the larva in the soil and for which data were obtained only at Kullaberg, killed three per cent of the hosts collected in that locality.

The only published information on parasite abundance is by Speyer (1940), who recorded *C. albicans* in 55 per cent of the cocoons reared from larvae collected in northern Germany; Delucchi (1953), who reported that 50 per cent of the larvae collected at Herznach, Switzerland, were parasitized by *C. albicans* and *L. dubia*; and Silvestri (1941), who found that 37 per cent and 23 per cent of the cocoons collected in the soil in south-central Italy in two years were parasitized by *A. abdominator* (= *Microcryptus brumatae* Silv.). In view of Silvestri's data and of the fact that it was studied only at Kullaberg in the present investigation, *A. abdominator* may also commonly be abundant. In spite of this, insect parasites, of which *C. albicans* is the most abundant, are unable to control the winter moth at an economic level because defoliation occurs commonly. One reason for the inability of *C. albicans* to regulate the abundance of *O. brumata* at a low level is that a proportion of its eggs are wasted,

except when there is complete defoliation; in addition Varley and Gradwell (1958) claimed that a large proportion of the parasite puparia died in the soil from unknown causes, and that parasite adult emergence was poorly synchronized with host larval development.

The following information was obtained on factors that affect the incidence of parasitism by each species.

(i) *Larval Competition.* Multiparasitism was recorded rarely in large scale rearings and numerous dissections: occasionally a puparium of *C. albicans* and one of *P. obscura,* neither of which produced an adult, were dissected from the same host cocoon. Theoretically, the larvae of *L. dubia, P. crassiuscula* and *A. abdominator,* which kill the host before it pupates, survive when competing with those of *C. albicans,* that feed only in the salivary gland of the winter moth larva and do not mature until after the host pupates. In nature, however, larvae of *L. dubia* and *P. crassiuscula* were never sufficiently abundant to affect appreciably the survival of *C. albicans*; and more data on the incidence of *A. abdominator* would permit an estimate of its effect.

Hyperparasitism caused little mortality: the greatest incidence was recorded at Luscherz, Switzerland, where approximately five per cent of the puparia of *C. albicans* contained adults of *Perilampus ruficornis* (Fabr.) (Hym., Perilampidae).

Superparasitism was recorded most frequently among larvae of *C. albicans* at Kullaberg, where incidence of parasitism by this tachinid was unusually high but, mostly because of their scarcity, was extremely rare among all other parasite species. Tests showed that several first-instar larvae of *C. albicans* could settle in the salivary glands of one host, that there was no active competition between the parasites at this time, and that they did not prevent host larval maturation or pupation; moreover, several respiratory funnels occasionally were formed in each host pupa, and supernumerary parasites were eliminated soon after these funnels were formed. Though many larvae of *C. albicans* are killed by superparasitism, one usually matures in each parasitized host, even if the latter has ingested at least 30 parasite eggs. Therefore, superparasitism does not reduce incidence of *C. albicans* in winter moth, but limits its increase at high parasite densities.

(ii) *Alternative and Alternate Hosts.* Five of the six most abundant parasite species (*C. albicans, L. dubia, P. obscura, A. flaveolatum,* and *A. abdominator*) are univoltine. Of these, *A. flaveolatum* commonly develops on other host species (Thompson, 1957), as do *L. dubia* and *P. obscura* (Van Emden, 1954), and *A. abdominator* (Rosenberg, 1934), whereas the most abundant parasite, *C. albicans,* though ingested by larvae of many species, matures mainly in winter moth (Wylie, in preparation). Though these facts are suggestive, the extent to which the abundance of each parasite species is determined

by whether it is univoltine and specific in its host relations could be determined from more extensive studies.

(b) Predators

No predator species apparently feed commonly on winter moth. Adults of *Raphidia major* Burm. (Raphidoidea, Raphidiidae) were observed feeding on larvae on three occasions at Schorndorf, Germany. Ants were noted carrying larvae on the ground at Schorndorf and Oberflockenbach, Germany; it is unknown whether they attacked caterpillars on the foliage or captured them after they had dropped. The following insect species were recorded in the literature as predators of winter moth larvae: *Calosoma inquisitor* (L.) (Col., Carabidae) (Escherich, 1931; Silvestri, 1941), *Cantharis rustica* Fall. (Col., Cantharidae) (Jahn, 1944), *Deraeocoris* sp. (Hem., Miridae) and *Formica cinerea* Mayr. (Hym., Formicidae) (Silvestri, 1941). Species that are known to attack winter moth pupae are *Athous* sp. and *Melanotus crassicollis* (Er.) (Col., Elateridae) (Silvestri, 1941). Female moths were eaten by unidentified Coleoptera and Dermaptera (Jary, 1931). Other insect species that are predaceous on winter moth are *Xylodrepa* (= *Silpha*) *quadripunctata* (L.) (Col., Silphidae) and *Panorpa communis* L. (Mec., Panorpidae) (Escherich, 1931), and *Polyergus rufescens* Latr. and *Formica rufa* L. (Hym., Formicidae) (Silvestri, 1941).

Spiders kill both feeding larvae (Silvestri, 1941) and adults (Jary, 1931). Vertebrate predators include toads (Silvestri, 1941), the lizard *Lacerta sicula* Raf. (Silvestri, 1941), both of which eat mature larvae on the ground, and several species of birds which destroy feeding caterpillars and adults (Silvestri, 1941; Betts, 1956) and possibly a few exposed pupae (Anon., 1952).

(c) Miscellaneous

No natural virus infection in winter moth was found in the present study or recorded by previous investigators. Larvae that were collected on oaks at Bingen in 1954 and 1955 did not become infected when reared in cages with diseased specimens of *Erannis defoliaria* (Clerck) (Lep., Geometridae) from the same locality. Smith (1955) observed a high mortality from a cytoplasmic polyhedrosis in caterpillars fed leaves sprayed with a mixture of two nuclear polyhedroses from *Vanessa cardui* (L.) (Lep., Nymphalidae), but there was no mortality in identical tests the following year (Smith and Rivers, 1956). It was suggested in this publication that some winter moth larvae contain a latent cytoplasmic virus that becomes lethal after introduction of a foreign virus.

Silvestri (1941) observed larvae killed by a fungus of the genus *Botrytis* in one locality in central Italy, and Speyer (1939) reported high larval and pupal mortality in laboratory rearings caused by *Isaria farinosa* (Dicks.) Fr. and another parasitic fungus, though it is unknown whether either infects winter moth naturally. Grison

(1956) recorded a high mortality in the laboratory of winter moth larvae that had been fed for several days on leaves sprayed with a suspension of spores of a strain of *Bacillus thuringiensis* Berl.

A small proportion of larvae collected in the present investigation at Frankfurt were killed by a microsporidian that was subsequently described as *Thelohania cheimatobiae* sp. n. (Krieg, 1956).

One dead immature parasitic mermithid nematode was dissected from a pupa of *O. brumata* that had been collected as a larva at Schorndorf. Silvestri (1941) reared mermithids from winter moth larvae from central Italy.

(d) Intraspecific Competition

Severe outbreaks that result in destruction of all suitable foliage locally or over a large area occur commonly in Europe (e.g. Thiem, 1922; Silvestri, 1941; Kozhanchikov, 1950), and cause larval starvation, as recorded at Kullaberg in the present study. Larvae that eat all the foliage on preferred host species may then attack other species on which they usually do not feed (Kozhanchikov, 1950); however, this does not always prevent mortality because the larvae readily feed on foliage on which they cannot mature (Thiem, 1939). High larval population densities also reduce the amount of food eaten by each larva which, as shown by Kozhanchikov (1950) increases pupal mortality. In addition, larval overcrowding reduces the size of the moths that eventually emerge, and, hence, the number of eggs laid by each: females that developed from mature larvae that had defoliated trees at Kullaberg did not exceed 7.0 mm. in length and laid up to 67 eggs each in the laboratory, whereas females from Versailles and Oldenburg, where there was no shortage of food, were up to 9.2 mm. long and laid up to 315 eggs each.

STAND FACTORS

Females composed 53.3 per cent of the winter moth adults in laboratory rearings at Hasselt, Belgium, 53.5 per cent at Oostmalle, Belgium, 54.3 per cent at Frankfurt, 55.2 per cent at Oldenburg, 55.3 per cent at Wytham, England, and 60.1 per cent at Versailles, but only 40 per cent of those trapped on grease-banded trees in several localities by Paillot (1922), Zirnits (1933) and Jancke (1937). The smaller percentage of females on trees is probably caused by the fact that many females, that cannot fly, are unable to find the trees, either because natural barriers on the ground inhibit searching, or because the trees are widely separated or small. Light intensity, as determined both by thickness of the stand and by weather, also probably affects the searching ability of females by affecting the distance at which the trees are visually perceived (Grison and Silvestre de Sacy, 1954).

SUMMARY

Climatic factors that occasionally affect the abundance of the winter moth in Europe include low temperature late in autumn that

prevents mating and oviposition, and high temperatures late in autumn and extremes of soil moisture that increase pupal mortality; the latter factors kill more male than female pupae. There is, however, no evidence that any climatic factor directly affecting adults, eggs, or pupae limits the abundance of the species; the importance of the indirect effect of temperature on survival of first-instar larvae is unknown. *Cyzenis albicans* (Fall.) is the most abundant parasite species; eleven other species, though common, are seldom abundant; and 14 others were recorded rarely. Factors that limit the efficiency of *C. albicans* as a biological control agent are discussed. Inter- and intraspecific competition among parasite larvae is not important in determining the incidence of each parasite species. Defoliation, which increases larval and pupal mortality and reduces adult fecundity, occurs commonly.

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SYNDEMIS MUSCULANA HÜBNER (LEP., TORTRICIDAE) IN CONIFER PLANTATIONS AND FOREST NURSERIES IN THE BRITISH ISLES

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In recent years studies on the biology and distribution of a number of Lepidoptera have shown that certain species have transferred their attention, particularly as larvae, from their normal host-plants to conifers growing or planted in the British Isles.

Within the Macrolepidoptera, examples include *Orgyia antiqua* L. (Vapourer Moth), *Orthosia gothica* L. (Hebrew Character) and *Ceramica pisi* L. (Broom Moth). Also *Melanchra persicariae* L. (Dot Moth), of which both the eggs and the larvae may be found on larch (*Larix*).

In forest nurseries a wide range of conifer seedlings and transplants, especially larch, spruce (*Picea*) and pine (*Pinus*) are defoliated by larvae of the following species, *Hadena trifolii* Hufn. (Nutmeg Moth), *Biston betularia* L. (Peppered Moth) and *Apatele rumicis* L. (Knotgrass Moth). Species of Geometrid larvae in the Winter Moth group also cause considerable damage in the spring to the young flushing shoots of spruce and Douglas fir (*Pseudotsuga taxifolia*), where the young plantations have been planted under oak (*Quercus*).

A number of Microlepidoptera species have also been found in conifer plantations and forest nurseries, and some of these have been listed in a previous paper (Styles, 1959).

For a number of years small numbers of larvae of an unidentified species of tortricid have been collected from a wide range of localities during field surveys in larch and spruce plantations and in forest nurseries. A difficulty was at first experienced in rearing this species, as it passed the winter in diapause as a mature larva, spinning a silken tube between the leaves of the food-plant or constructing a loose cocoon in the leaf litter on the ground.

After a number of unsuccessful attempts to over-winter larvae in the laboratory had been tried, three adults were reared in 1959 from larvae collected the previous autumn at Radnor Forest, near Presteigne, Wales. These were identified by Mr. J. D. Bradley, of the British Museum (Natural History), as *Syndemis musculana* Hübn.

Descriptions of the adult moth and the larva, and also some notes on the biology and a list of the localities from which *S. musculana* have been collected, are given below.

Adult Moth (Plate V, Fig. 1)

The adult moth has a wing-span of 18-20 mm. and a body length of 6-8 mm. The forewings are pale brown, with a wide transverse chocolate, medial, brown bar, edged with chestnut, and a similar narrow patch towards the wing tips. The undersides of the forewings

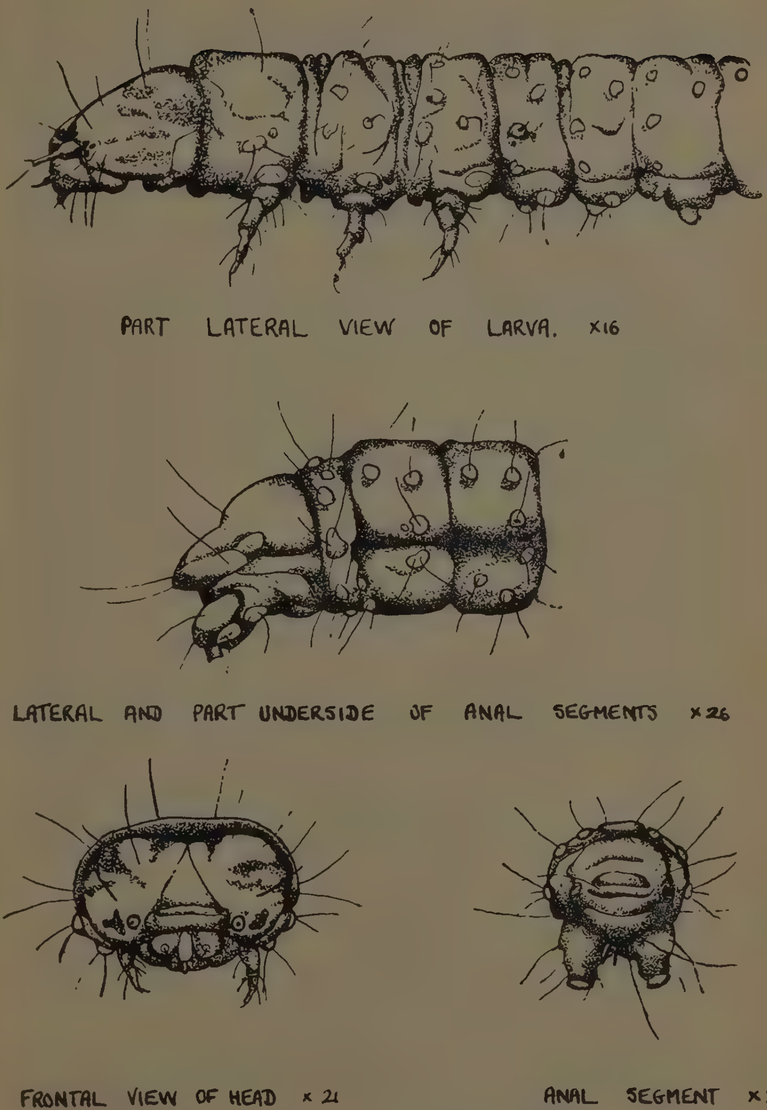

Fig. 1. Larva of *Syndemis musculana* Hübner.

are pale brown. The hindwings are pale brown in colour above and below. The forewings and hindwings are fringed with greyish cilia. The upper surface of the head, thorax and abdomen is grey-brown, gradually changing to light brown on the underside. The eyes are chocolate brown, and the filiform antennae mottled brown, with paler undersides.

Syndemis musculana closely resembles *Syndemis afflictana* Walker, from North America, superficially and in genitalia structure. The two species may eventually come to be considered as geographical sub-species (Freeman, 1958).

Larva (Fig. 1 and Plate V, Fig. 2)

The mature larva is 12-18 mm. in length, with a glossy, well-chitinized, orange-brown head and opaque antennae; the thoracic plate is also well chitinized and is glossy grey-black to brown with an opaque central portion. The body colour varies considerably and may be olive green or grey brown, dotted with prominent grey spots, each containing one or two fine opaque hairs. A wide grey-brown line extends right along the dorsal surface of the thoracic and abdominal segments. The underside of the body is pale grey to brown or green, and the chitinized anal segment is glossy light to dark brown, dotted with fine opaque hairs.

Biological Notes

Like other Tortricid species, the larvae remain concealed between the leaves of the food-plant, which are spun together for protection. On conifer, especially larch, the needles are spun together to form a compact silken tube, while on hardwoods the edge of the leaf is curled over and secured with silk. There is only one generation a year. The adult moths emerge in May and June, and the larvae may be collected from July to October.

In Great Britain the recorded food-plants of this species are bramble (*Rubus*), oak, and birch (*Betula*), (Ford, 1949; Meyrick, 1928). No larvae have been collected by the author from bramble, although this food-plant has been examined in a number of localities. Collection of larvae is made difficult by the fact that bramble is a prickly plant and the larvae remain concealed in a folded portion of the leaf.

Distribution

In the British Isles mature larvae have been collected from larch plantations in the following areas:

Scotland: The Athol Estates, Dunkeld, Perth; Kirroughtree Forest, Kirkcudbright; Monaughty and Teindland Forests, Moray; Drumtochty Forest, Kincardine.

Wales: Radnor Forest, near Presteigne, Radnorshire.

England: Mortimer Forest, Hereford; Plymouth, Devon.

Larvae have also been collected from spruce plantations at Redesdale Forest in Northumberland.

In forest nurseries larvae have been found causing damage to young conifer seedlings, especially larch, pine and Douglas fir, during the late autumn at Millbuie Forest, Ross and Cairn Edward Forest, Kirkcudbright, and Bramshill Forest in Hampshire.

In June, 1959, first instar larvae were collected from larch plantations at Mortimer Forest, and it is suspected that the eggs may also be found on this food-plant. Besides the three adults from Radnor Forest previously mentioned, a single specimen was also reared in the laboratory from a larva collected from spruce growing under oak at Alice Holt Forest in 1951. Adults have also been taken on the wing by day at Mortimer Forest in May, 1959.

In Germany the larvae are recorded as being polyphagous on trees, shrubs and grasses (Wolff and Krausse, 1922; Spuler, 1910). In Russia *S. musculana* is local in all areas except the extreme north, and the larvae are found to be polyphagous on trees and shrubs, especially oak. Other known food-plants include willow (*Salix*), birch, mountain ash (*Sorbus aucuparia*), aspen (*Populus tremula*) and lime (*Tilia*), (Arnoldi and others, 1955).

Although the adults of *S. musculana* have been taken on the wing by Dr. S. Issiki in the Nagano Prefecture of Honshu in Japan, there are no records of the larvae feeding on larch, and the food-plant in Japan is unknown.

A Tortricid species has also been reported from North America as *S. musculana*, but the records appear to refer to *S. afflictana*, which feeds upon fir (*Abies*) and other conifers.

SUMMARY

In recent years a number of Lepidoptera species have been found transferring their attention, particularly as larvae, from their normal food-plants to conifer plantations in the British Isles. *Syndemis musculana* Hübn., previously recorded in this country from bramble, birch and oak, is now found to be widely distributed in larch plantations in the British Isles. Damage may also be caused by the larvae to young conifer seedlings growing in forest nurseries.

ACKNOWLEDGEMENTS

This paper is published with the permission of the Forestry Commission. Thanks are due to Mr. J. D. Bradley, of the British Museum (Natural History), for the identification of the adults; Mr. K. Heppell for the line drawings of the larva; Mr. R. C. Kirkland for specimens of larvae collected over a number of years from various localities in the British Isles; and other members of the Entomology Section of the Forest Research Station, who have helped in the preparation of this paper.

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TWO EXAMPLES OF PROTECTIVE RESEMBLANCE IN LEPIDOPTERA

By T. G. HOWARTH
Department of Entomology, British Museum (Natural History)

Cilix glaucata Scop. (The Chinese-character) and *Eupithecia centaureata* Schiff. (The Lime-speck Pug) are two species which, in their imaginal state, resemble bird droppings when at rest. It may be of interest to place on record an instance which was observed of the apparent effectiveness of this type of protective resemblance.

A Robinson mercury vapour light trap has been run regularly on the lawn at home in Arkley, Herts, since 1951. Birds are frequent visitors soon after dawn, feeding on the insects that have been attracted to the light and have remained at rest on the trap or in the immediate vicinity. During May, 1954, the two species mentioned above were much in evidence and it was noticed that although often in conspicuous positions they were apparently being overlooked by the birds, mainly robins, sparrows and blackbirds, that visited the trap.

On Plate V, Fig. 3, is a reproduction of a photograph taken in the late afternoon of the trap in situ showing two specimens of *glaucata* and seven *centaureata* at rest amongst bird droppings on the trap which had not been moved or covered during the day.

It is of interest to note that when resting on a vertical surface, *centaureata* always spreads its wings flat on the resting surface usually in a line somewhere between an angle of 70° and the perpendicular, while *glaucata*, in the same situation, sits with its body in a vertical position with its wings tented over its back. Thus it will be seen that both species achieve the same degree of resemblance to a streak made by a semi-liquid bird dropping but in an entirely different manner. A possible explanation for the difference in resting position is that *centaureata* normally seems to prefer a vertical surface such as a tree-trunk or fence, while *glaucata* prefers a horizontal surface, such as the upper side of a leaf, where its correct orientation would then not be of such importance.

CHROMOSOME NUMBERS OF LEPIDOPTERA—PART I

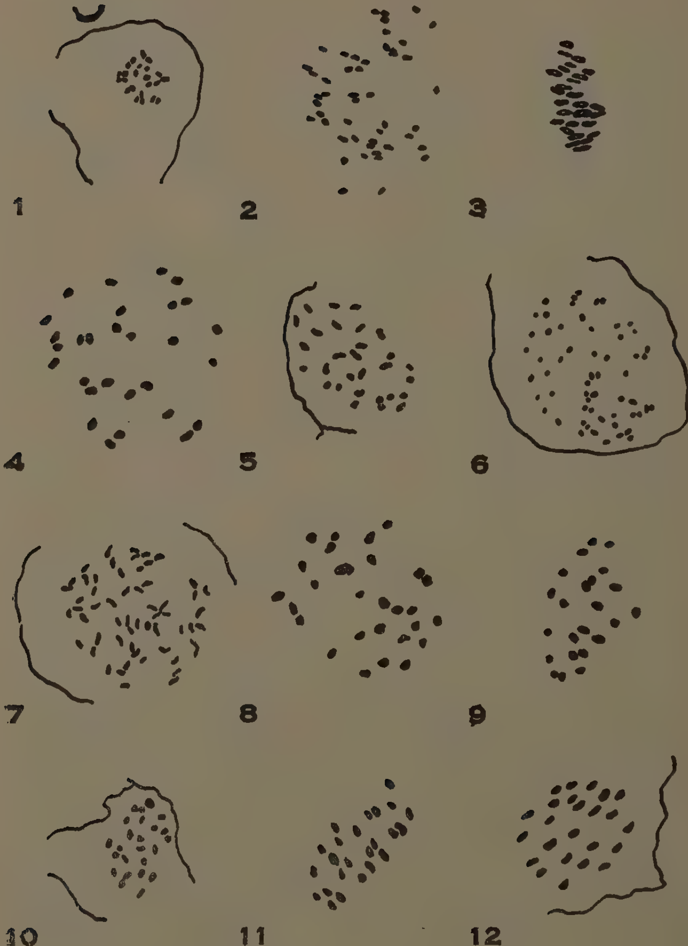
By T. R. L. BIGGER

Lepidoptera chromosomes are on the whole numerous and small in size. The numbers found so far range from a haploid number of ten up to one hundred and twelve. The following twenty-five species were selected to give a fairly general, though somewhat scanty, picture of the variation in size and number of chromosomes between distantly and closely related species.

Chromosomes can only be seen during the dividing stage of a cell, and therefore preparations for study are made from a tissue which is undergoing rapid and numerous divisions. The testis is a good example of an organ undergoing such division. Two types of division may be found to occur; firstly, mitotic, or the normal process of cell division; and secondly, meiotic, or the process of gamete formation. The actual number of chromosomes in a particular species can only be seen at the metaphase of both types of cell division, and in a few cases at early anaphase if the preparation is a good one. It is at metaphase that the chromosomes are fully contracted and separate from one another. In meiotic divisions at metaphase only half, or the haploid, number of chromosomes are visible as they pair up; whereas in mitotic divisions no pairing takes place and all the chromosomes are visible.

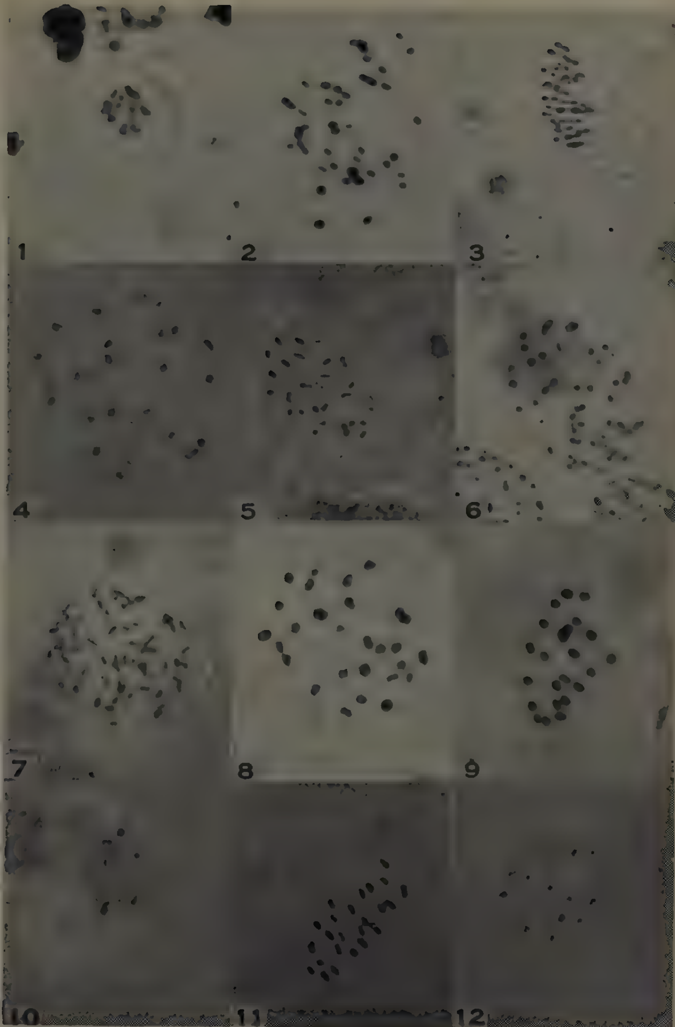
Male specimens were used as there are more divisions present in the testis than in any other tissue. Testes were dissected out and fixed in an acetic-alcohol mixture (1 : 3 glacial acetic acid to absolute alcohol) for approximately twenty-four hours, then hydrolized in 1N hydochloric acid for seven minutes at 60° C., and stained for three hours in feulgen leuco-basic fucsin. The stained testes were then macerated on a slide and squashed beneath a coverslip between sheets of blotting paper, enough pressure being applied to spread the cells out to form a single layer. The slides were then frozen on solid carbon dioxide which enables the coverslip to be removed and the squashed cells are left on the slide. These are then dehydrated in alcohol and mounted in euparal. Several slides were made for each species, using testes from different individuals, and as many unbroken cells as possible were scored.

It was found that some testes responded to treatment better than others with respect to staining and squashing. Those of the Lycaenidae were very easy to handle and good preparations were made, with the chromosomes spread out well in one plane; this makes scoring and photographing very much easier, and as it may be seen from the accompanying photomicrographs (Plates) perfect results were not always possible. As a result of this, diagrams (Text Figs. 1-25) have been drawn to the same scale as the photomicrographs, straight from the actual cell on the slide. The photomicrographs are all x1500, and give a clear impression of the different sizes of chromosomes



CHROMOSOMES OF LEPIDOPTERA

Figs. 1-12: For explanation see page 151



Chromosomes of Lepidoptera. Photomicrographs x 1500.
For Key see opposite page.

to be found. They show meiotic and mitotic metaphases, and one very early anaphase.

The following table sets out the number of chromosomes found for each species examined:

	n=Haploid		n=Haploid
SATYRIDAE	No.	PIERIDAE	No.
Aphantopus hyperantus (L.)	23	*Pieris brassicae* (L.)	15
Agapetes galathea (L.)	24	*P. napi* (L.)	25
Pararge aegeria (L.)	27	*P. rapae* (L.)	25
Coenonympha pamphilus (L.)	29	*Euchloë cardamines* (L.)	30
Maniola jurtina (L.)	29	HESPERIIDAE	
Manola tithonus (L.)	29	*Augiades venata* (Ver.)	13
NYMPHALIDAE		*Thymelicus sylvestris* (Poda)	27
Aglais urticae (L.)	29	*Erynnis tages* (L.)	31
Argynnis aglaia (L.)	29	*Pyrgus malvae* (L.)	33
LYCAENIDAE		NOCTUIDAE	
Polyommatus icarus (Rott.)	23	*Amathes xanthographa* (Schiff.)	34
Aricia agestis (Schiff.)	24	ZYGAENIDAE	
Cupido minimus (Fues.)	24	*Zygaena trifolii* (Esper)	30
Lycaena phlaeas (L.)	24	PYRALIDAE	
Lysandra coridon (Poda)	90	*Perinephala coronata* (Hufn.)	10
		Eurrhypara hortulata (L.)	28

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Rush Common House,
Abingdon, Berks.

CHROMOSOMES OF LEPIDOPTERA

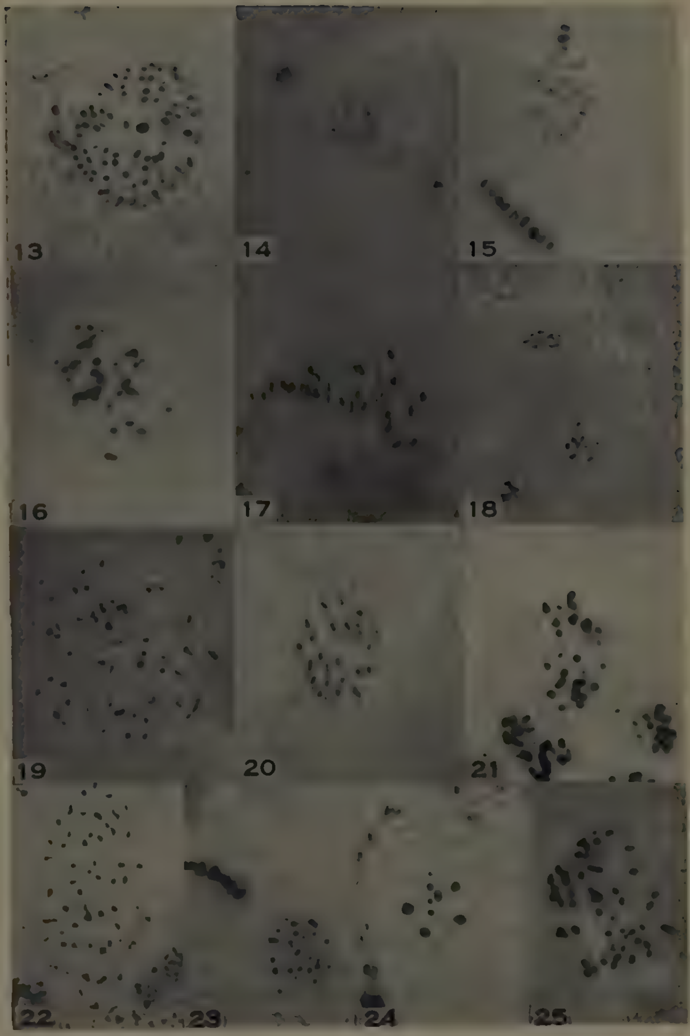
Figs. 1-12.—1, *Aphantopus hyperantus* (L.)—Meiosis: 1st Metaphase n=23; 2, *Agapetes galathea* (L.)—Mitosis: Metaphase n=24; 3, *Pararge aegeria* (L.)—Meiosis: 1st Metaphase (late) n=27; 4, *Coenonympha pamphilus* (L.)—Meiosis: 1st Metaphase n=29; 5, *Maniola jurtina* (L.)—Meiosis: 1st Metaphase n=29; 6, *Maniola tithonus* (L.)—Mitosis: Metaphase n=29; 7, *Aglais urticae* (L.)—Mitosis: Metaphase (early) n=29; 8, *Argynnis aglaia* (L.)—Meiosis: 1st Metaphase n=29; 9, *Polyommatus icarus* (Rott.)—Meiosis: 1st Metaphase n=23; 10, *Aricia agestis* (Schiff.)—Meiosis: 1st Metaphase n=24; 11, *Cupido minimus* (Fues.)—Meiosis: 1st Metaphase n=24; 12, *Lycaena phlaeas* (L.)—Meiosis: 1st Metaphase n=24.

CHROMOSOMES OF LEPIDOPTERA

Figs. 13-25.—13, *Lysandra coridon* (Poda)—Meiosis: 1st Metaphase n=90; 14, *Pieris brassicae* (L.)—Meiosis: 1st Metaphase n=15; 15, *Pieris napi* (L.)—Meiosis: 1st Metaphase n=25; 16, *Pieris rapae* (L.)—Mitosis: Metaphase n=25; 17, *Euchloë cardamines* (L.)—Meiosis: 1st Metaphase n=30; 18, *Augiades venata* (Ver.)—Mitosis: Anaphase (early) n=13; 19, *Thymelicus sylvestris* (Poda)—Mitosis: Metaphase n=27; 20, *Erynnis tages* (L.)—Meiosis: 1st Metaphase n=31; 21, *Pyrgus malvae* (L.)—Meiosis: 1st Metaphase n=33; 22, *Amathes xanthographa* (Schiff.)—Meiosis: Metaphase n=34; 23, *Zygaena trifolii* (Esper)—Meiosis: 1st Metaphase n=30; 24, *Perinephala coronata* (Hufn.)—Meiosis: 1st Metaphase n=10; 25, *Eurrhypara hortulata* (L.)—Mitosis: Metaphase n=28.

CHROMOSOMES OF LEPIDOPTERA

Figs. 13-25: For explanation see page 151



Chromosomes of Lepidoptera. Photomicrographs x 1500.
For Key see opposite page.

THE LARVA OF *HALESUS RADIATUS* (CURTIS) (TRICH., LIMNEPHILIDAE)

By HILMY M. HANNA, Ph.D., F.R.E.S.
Assiut University, Egypt

The larvae of this species were found to be fairly common in the Kennet Canal near Reading. On 4th March, 1954, forty-seven fully-grown specimens were collected. They were found on the roots of the vegetation at the edges of the canal, and were in company with the larvae of *Limnephilus marmoratus* Curt., *Limnephilus flavicornis* (F.) and *Anabolia nervosa* (Curt.). Many larvae were reared to maturity and the adults were identified as *Halesus radiatus*.

The larvae collected from the Kennet Canal were checked against specimens collected from the River Pang at Bradfield and from Woodley Brook at Woodley near Reading.

Case

The cases are up to 32 mm. long and 6mm. wide and are made of pieces of bark, stems and leaves of water plants. The anterior opening of the case is oblique, while the posterior opening is small and straight. The cases have one to three long sticks along their whole length. The sticks may reach thirty-eight millimetres in length. In some of the cases the sticks were absent, but large pieces of bark had been substituted.

Larva

The larva is eruciform. The larvae examined were up to 22 mm. in length and 5 mm. in width.

Head

The head is hypognathous and ovoid in shape. The frontoclypeus is yellowish-brown or chestnut-brown in colour and has black patterns. There are four long setae at the oral end of the frontoclypeus and two short ones at its constrictions. The anterior surfaces of the genae are yellowish-brown and have large distinct black spots. The eyes are surrounded by lighter areas. The posterior surfaces of the genae are dark brown except for two areas above the labium and two areas on both sides of the occipital foramen. The latter areas bear black spots. The gular sclerite does not separate the genae completely.

Labrum

The ventral margin of the labrum has a concavity, on each side of which there are five long setae, a short seta and a group of marginal hairs. The margins of the labrum are highly sclerotised and are darker than the rest of the labrum. The labrum has a dark brown central spot. The tormae are thick and short and are bent inward.

Mandibles

Each mandible has four teeth, a hairy brush on its inner surface and two setae on its outer surface near the base.

Maxilla

The cardo is small and has two setae. The distal margin of the stipes has two setae. The maxillary palp has five segments, of which the basal segment has many hairs. The lacinia is furnished with a few sensilla and many hairs.

Thorax

The pronotum is yellowish-brown, entirely sclerotized, and has a median longtitudinal suture and many black spots. The posterior and posterolateral margins of the pronotum are highly sclerotised and are dark brown in colour. The pronotum has a groove along its anterior third and has two dark brown areas on its anterior half. The pronotum has fine hairs and a few setae along its anterior margin. There are also some setae on its anterolateral corners and on both sides of the median suture. The mesonotum is sclerotized except for its lateral and posterior margins. The sclerotized area is chestnut-brown except for its posterior corners which are golden yellow and have a black spot. The posterior and posterolateral margins of the sclerotised area are even more sclerotised and are black in colour. There are many black spots on both sides of the median suture. The metanotum has six small sclerites, each of which has some setae. The outermost sclerites of the metanotum have dark brown spots. The prosternal horn is present and well developed.

Legs

The prothoracic leg is short and robust, while the mesothoracic leg is slightly longer than the metathoracic leg. The femora, tibiae and tarsi of all the legs bear small spines. There are two additional long spines and a few hairs on the femora of the prothoracic legs. The second segments of the trochanters of all the legs have a group of fine hairs. There are dark brown spots on the coxae, trochanters, femora and tibiae of all the legs. There are two spurs on the tibiae of each leg.

Abdomen

On the first abdominal segment there are three protuberances, of which the dorsal one is devoid of setae, while the two lateral ones have a few setae. The tergum and sternum of the first abdominal brown spots. The gill filaments are single and are present on ab- segment bear a group of setae, at the bases of which there are dark dominal segments one to seven. The lateral line running from the beginning of the third to the beginning of the eighth abdominal segments is formed of fine hairs. Above the lateral line there are dark brown sclerotized pustules in groups of four to nine on abdominal segments three to seven. In a few specimens these pustules were absent on the sixth segment. There are elliptical pale yellow sclerites on the sterna of the second to the seventh abdominal segments. In one specimen the sclerite on the sternum of the second abdominal segment was absent. The anal sclerite, which is elliptical, has yellowish-brown spots along its anterior margin and four long setae and a few short

setae along its posterior margin. The anal appendage has two segments and the anal claw has an auxiliary claw at its base. The anal appendage is supported by a golden yellow sclerite which has yellowish-brown spots and a few setae. There are two long setae and a short seta between the anal appendage and its supporting sclerite.

The genus *Halesus* is represented by four species on the British list of Trichoptera: *H. digitatus* (Schranck) *H. radiatus* (Curt.) *H. auricollis* (Pict.) and *H. guttatipennis* McLach. The larvae of the two last species have not yet been described. The larvae of *H. digitatus* and *H. radiatus* are approximately equal in length, build similar cases and generally have the same appearance. Hickin (1949) pointed out that in *H. digitatus* the labium is hairy, the mesonotum is without pale areas and the pustules of the lateral line are indistinct. From Hickin's figure of the thorax one sees that the dark spots are absent on the anterior half of the pronotum. In *H. radiatus* the labium is much less hairy, the mesonotum has two lighter areas, the pustules of the lateral line are distinct and the dark spots are present on the anterior as well as on the posterior half of the pronotum.

Lestage (1921) and Ulmer (1903 and 1909) pointed out that the larvae of *H. auricollis* Pictet are 13-15 mm. long, the head, the pronotum and the mesonotum are dark brown in colour and the cases of the fully-grown larvae are made of sand grains and small stones.

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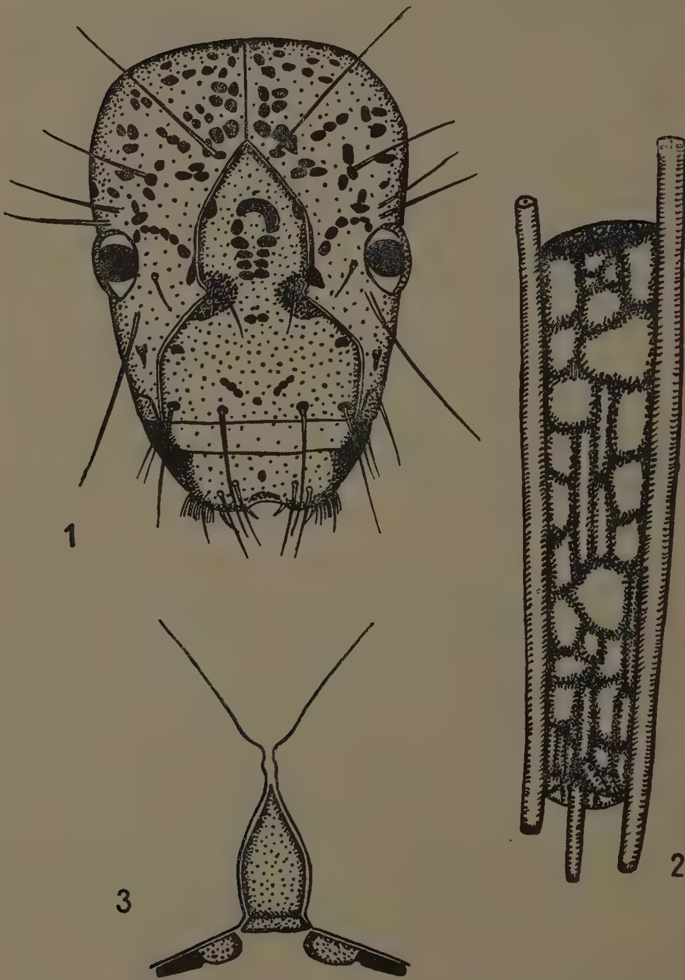
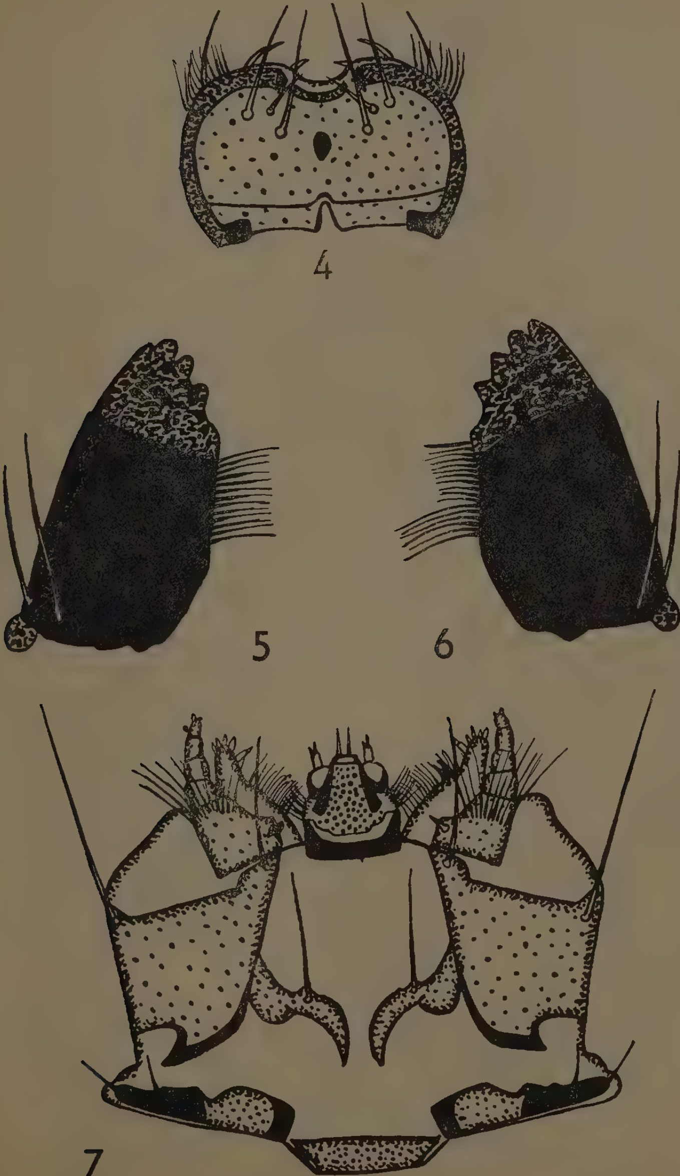
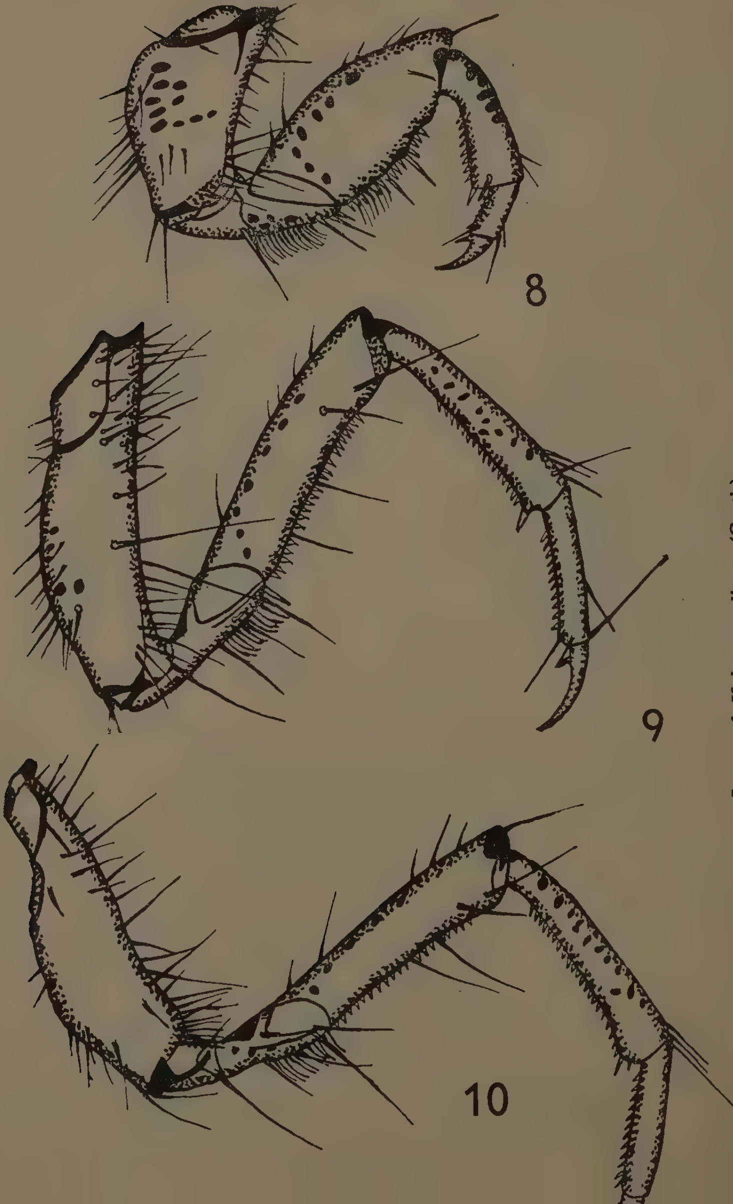


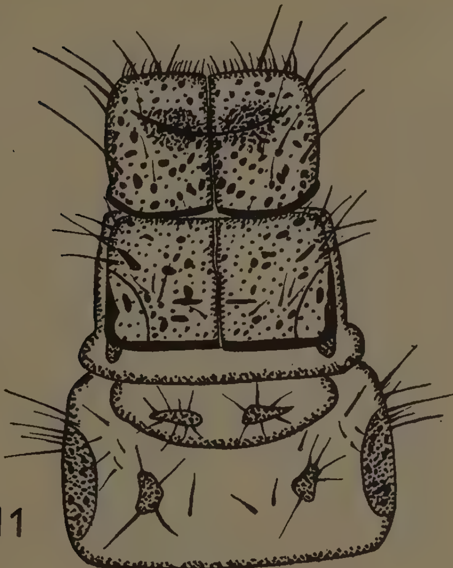
Larva of *Halesus radiatus* (Curtis).
Figs. 1-3: (1) Head from the front. (2) Larval case. (3) Gular sclerite.



Figs. 4-7: Larva of *Halesus radiatus* (Curtis). (4) Labrum. (5) Left mandible. (6) Right mandible. (7) Labium and maxillae.



Larva of *Halesus radiatus* (Curtis).
Figs. 8-10: Prothoracic leg. (9) Mesothoracic leg. (10) Metathoracic leg.



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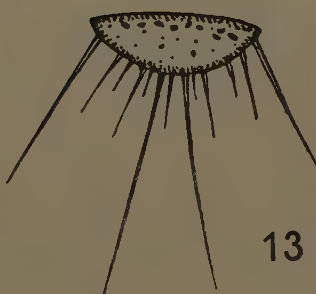

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Larva of *Halesus radiatus* (Curtis).
Figs. 11-13: (11) Thoracic nota from above. (12) Anal appendage, supporting sclerite and anal claw (side view). (13) Anal sclerite from above.

RECORDS OF LEPIDOPTERA FROM S.W. MIDDLESEX IN 1959

The Middlesex fauna is vanishing so rapidly that I am prompted each year to place on record the lepidoptera of interest taken in my garden in Feltham.

At a somewhat distant date the district was part of the once extensive Hounslow Heath ('Highwaymans Heath' of the history books), and was on the edge of a fenny area bordering the Longford and Duke of Northumberland's rivers.

Relict members of the aboriginal fauna exist in dwindling numbers side by side with other insect species which were probably dominant at the time when the district consisted largely of market gardens—and was indeed known as 'London's Garden'. This period was ending just before the 1939–45 War. Now bricks and mortar have covered almost everything and rural Middlesex is represented by only a few small areas on the fringe of the county—and none of them to my knowledge of the same nature as this one.

During 1959 the following lepidoptera were of particular interest, all of them were taken in a mercury vapour light trap:

Cerura hermelina Goeze, one 14th July. *C. furcula* L., one 18th July. *Leucoma salicis* L., one 23rd June. *Gastropacha quercifolia* L., one 3rd July. *Drepana binaria* Hufn., one 7th July, two 23rd August. *Earias clorana* L., one 26th June, one 4th July, one 14th August. *Bena prasinana* L., one 22nd June, one 21st August. *Pseudoips bicolorana* Fuessl., one 25th June, one 5th July. *Cybosia mesomella* L., one 23 June. *Eilema griseola* Hübn., one 1st August. *E. griseola* var. *flava* Haw., one 9th July. *Apatele leporina* L., one 3rd July, one 18th July. *Amathes glareosa* Esp., one 23rd September. *Polia tincta* Brahm., one 23rd June. *Hadena contigua* Vill., one 27th June. *Cerapteryx graminis* L., one 9th July, one 18th August. *Aporophyla lutulenta* Borkh., one 22nd September, three 23rd September. *Nonagria typhae* Thunb., one 27th July, one 1st August. *N. geminipuncta* Haw., var. *nigricans* Stdgr., one 1st August. *N. geminipuncta* var. *obsoleta* Tutt, one 13th August. *Cosmia diffinis* L., one 18th July. *Zenobia subtusa* Fab., one 18th July. *Cucullia absinthii* L., one 27th July, one 6th August. *Plusia festucae* L., one 8th August. *Lygephila pastinum* Treits., one 4th July. *Parascotia fuliginaria* L., one 15th August (a very late date). *Gnophos obscurata* Schiff., one 1st August, one 6th August, one 11th August. *Zeuzera pyrina* L., one 3rd July. *Lozotaeniodes formosana* Fröl., one 23rd June, one 26th June, one 8th July, one 27th July.

E. W. Classey.

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THE EARLY STAGES OF *SPAELOTIS RAVIDA* HÜBNER (LEP., NOCTUIDAE)

By G. HAGGETT

In July, 1959, Mr. A. L. Goodson caught nine female *Spaelotis ravida* in mercury vapour light traps in the Tring neighbourhood and he kept all alive for eggs, but only one laid and this after being imprisoned for five weeks. The eggs were laid from 11th-13th September, at which time they were handed over to me; most were scattered on the sides and glass of a collecting pillbox, and many were splashed by the moth's meconium which dried out a dusty pink, but which did not prevent the eggs from hatching successfully.

During their first week the colour of the eggs changed from pearly-white when newly laid to a pale yellow, darkening further during the second week to grey, and then to black, and finally in the third week to the gun-metal grey that is characteristic of an insect egg containing a larva ready to hatch. My mother had the handling of them, and in view of what had been written by Bretherton (1957, *Ent. Gaz.*, **8**: 3) and Lorimer (1959, *Ent. Gaz.*, **10**: 94) she decided to open one up to see whether or not there was life within; this she did on 5th October and a live larva was extracted which survived for 23 days without feeding. Many of the other eggs appeared to contain fully formed larvae, but some of these were later found to be dead. The eggs were kept in a tin in the coolest part of the house where the temperature rarely fell below 40 deg. F.

On 19th December one larva hatched, followed by two more on the 21st and others over the Christmas period into January; the bulk came out on 1st-2nd January and the last on the 8th. Out of a total of some 350 eggs laid we had 220 hatch. Most of the remainder were fertile, but the young larvae died despite frequent moistening done during the period the others were hatching.

The tiny larvae were put into glass phials each of which contained a small root of *Poa annua,* a dandelion leaf, and a loose plug of cotton wool in which the larvae hid. Some were given also a leaf of hawkbit and sowthistle. There were a few early deaths but most larvae began to eat the *Poa* blades, first only at the cuticle and then right into the leaf, and after a few days there was some feeding at the hawkbit and dandelion. Only during this first instar did grass constitute the main diet.

Larvae were kept in a warm room at between 50 deg. F. and 60 deg. F., and by 10th January the earliest to hatch were having their first moult. Within eight days some larvae had moulted again and yet again on 24th January. Since there were larvae of all sizes and ages at different stages of growth growing at different speeds a few were segregated to establish the number of instars.

After the third moult the larvae ate more dandelion and sow-

thistle and not so much grass. Later they would eat right through the heart of a young plant, boring through to the top of the root, and they also nibbled sliced carrot.

Things went favourably until the middle of February, when the first hatched larvae had already reached their last instar, and then a devastating virus raged through the tins and had pretty well wiped out the lot within a fortnight, but we did manage to get a number preserved. The disease developed simultaneously in the bulk being reared at Arundel and amongst the few I had with me in Norfolk: it took two forms, the first a kind of wasting disease in which the larva ceased to feed and sat moribund for 10-12 days before dying, the second developing so suddenly that overnight a fat and vigorous larva would be reduced to a wet and evil smelling heap.

The few larvae to reach full growth had passed five moults.

DESCRIPTIONS OF LARVAL INSTARS

First instar—A uniform sooty brown inclined to olive, first pair of prolegs weakly developed, jet black head and prothoracic plate, minute pale dorsal and subdorsal lines.

Second instar—More like *Amathes*, pale pinky brown with broad stone-coloured subspiracular band, fine straight subdorsal black streaks on all the abdominal rings to eighth, becoming bolder there, with fine oblique dusky arms running forward and outward from the posterior of each ring, and again at the sides above the small black spiracles. Head grey with a black stripe down each lobe, prothoracic and anal plates pale with darker freckling. Skin soft and naked but for sparse fine lateral hairs.

Third instar—Grey brown or warmer brown mottled in darker, the subdorsal black dashes very clearly defined, relieved by a paler edging outwardly. The dusky arms swept inwards as before to form a series of rather vague V marks. The lateral oblique shading as before. A conspicuous white dot at the subdorsal line at the beginning each of the third thoracic and first abdominal segment. Head grey brown with two blackish stripes in front and another at the sides. Prothoracic plate greyish much mottled with black and crossed by thin white dorsal and subdorsal lines. Broad stone-coloured subspiracular band and in many larvae a narrow black wedge adjacent to each black spiracle. The shape of *Amathes* and *T. comes*.

Sixth (*last*) *instar*—The descriptions given by Buckler (Vol. 5, p. 22) are very good, but his figures (Plate 73) are not of his usual clarity, although 3a and 3c show well enough the horseshoe marks that are typical of some larvae. The commonest form of the fully grown larva can be likened to that of *P. saucia* in that the greyish pink larva bears long fine black subdorsal streaks which culminate on the eighth abdominal ring in the urn-shaped figure that is common also to many of the *Amathes* larvae. In *ravida* these subdorsal streaks

are illuminated laterally by pale yellow and then often flanked again by a reddish band. The dusky grey forms are of the same peculiar ochreous ashy hue as *T. comes* and *R. simulans,* and there can be little doubt but that this larva is well placed amongst those species and their related Noctuids.

DISCUSSION

In his comprehensive survey of the species Bretherton drew attention to the remarkable fact that no account existed of *ravida* having been reared from the egg, and in the few years since his paper was published those attempts to obtain eggs have ended in failure or where eggs were at last laid they failed to hatch.

Uncertainty of reproduction is a feature of this group of moths sandwiched between the Darts and the Triphaenas and *Amathes*. It includes *augur, saucia, simulans* and *lucernea,* none of which is a ready layer nor easy to rear from the egg. Few are easily obtained wild in the larval state. Some of the related species have peculiarities of life-cycle and time of appearance of the moth, such as *A. ipsilon,* which may occur at any time from March until November, and attempts may be made abortively for years before eggs are suddenly showered out. Of the Triphaenas, *pronuba, fimbria* and *comes* may be seen from June until October, although they are properly out at mid-summer. *T. orbona* also flies in July, but eggs are obtainable from September moths.

There are one or two instances of wild *ravida* larva having been found in May, and it is reasonable to suppose that the habit of the species is for eggs to hatch at the turn of the year, and for larvae to grow slowly and develop as the perennial or biennial plant rosettes begin to sprout new foliage. It seems likely that Buckler's larvae had been found wild rather than having been bred from the egg. There is a fine series of blown larvae in the Rothschild-Cockayne-Kettlewell collection at Tring labelled 'Norfolk coast on *Artemisia,* 1st-16th May, 1928', and I would dearly like to know their origin; these, too, appear to be wild collected—but surely not from *Artemisia*?

PERINEPHALA PERLUCIDALIS HÜBNER (LEP., PYRALIDAE)

I should like to record that in the company of Mr. E. J. Hare on the nights of 5th and 6th June, 1960, at Woodwalton Fen, Hunts., we took ten *P. perlucidalis* Hübn. nearly all at dusk, a few at mercury vapour light. I believe this to be the earliest date so far.

D. MORE.

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ABNORMAL EXTRA BROODS OF MOTHS IN 1959

By R. F. BRETHERTON, C.B., M.A.

Some years ago I discussed (1953, *Ent. Gaz.*, **4**:287) the occurrence of double broods among moths in North West Surrey, and commented on the appearance of additional emergences in favourable seasons. The year 1959, with a fairly early spring and an exceptionally dry and sunny summer prolonged well into October, has provided much fresh information, which it seems worth while to record.

A number of species which are normally double-brooded appear to have produced a third brood in 1959. Thus the second emergence of *Drepana binaria* Hufn. began to appear in the mercury vapour trap on the 8th July, and 50 had been noticed by 14th August, when they were very worn, but 11 fresh examples arrived between 24th August and 5th September, which clearly represented a fairly strong third brood. For *D. cultraria* F. the dates were much the same, 13 being recorded between 6th July and 13th August, and a further three from 26th to 28th August; and of *Cilix glaucata* Scop. there was one belated specimen on 3rd September. *Agrotis puta* Hübn. had a rather weak spring brood from 7th May to 6th June. It began again, about a month earlier than usual, on 17th July, and continued to be very common until mid-August, with worn stragglers until the 27th. On 11th September two fresh examples came in, and altogether 65 more were scored up to 2nd November—about half the numbers of the second brood. *Rivula sericealis* Scop., after ending its second emergence in mid-August, produced four examples between 10th and 24th October. Among the Geometers, third broods were particularly noticed. *Gymnoscelis pumilata* Hübn. and *Opisthograptis luteolata* L. increased in numbers all through the season and, though there was certainly some overlapping between the broods, most of those which appeared in late August and September probably constituted a third, and the strongest, emergence. *Xanthorrhoe ferrugata* Clerck (Dark Twin-spot Carpet) showed what appeared to be a partial third brood, of which 11 individuals were seen, from 24th August to 5th September, and *X. fluctuata* L. produced a clearly defined and strong emergence in mid-September, straggling on until 6th October. There were two examples of *Anaitis efformata* Guen. on 3rd and 21st October, two of *Ectropis bistortata* Goeze on 2nd and 13th September, and one of *Calothysanis amata* L. on 9th October.

Almost all of the fully double-brooded species were in much greater force in the second brood than in the first. The first broods were mostly rather below normal numbers, probably as a result of the bad season in 1958, and the recovery to the very strong second broods was therefore very striking. *Mamestra brassicae* L., for instance, scored only 15 in the first brood against 117 in the second, *Ecliptopera silaceata* Schiff. 12 against 54, and *Leucania pallens* L. 233 to the end of July, and then a further 1,155, beginning after a short

gap and reaching the greatest abundance in the first week of September. Species which regularly produce small partial second broods also did well. The characteristic small, pale examples of *Cleora rhomboidaria* Schiff. first appeared at the end of August, before the first brood had quite gone, and about 20 were seen up to 3rd October —over 10 per cent of the first brood total; and the equally distinctive second emergence of *Hypena proboscidalis* L. gave a similar performance. In *Hadena bicruris* Hufn. the second brood is usually very small, but this year it actually scored 25 against 11. *Hypsopygia costalis* F. also produced a second brood, mainly in September, in greater strength than the first, contrary to its usual habit here. *Agrotis exclamationis* L., which is, after *Amathes c-nigrum* L., the most abundant moth in the trap, had previously produced a few examples of a second brood only in 1949, 1952 and 1955: in 1959 they began on 19th August, were quite common in early September, and straggled on until 9th October, to a total of nearly 70 specimens, about 2½ per cent of the first brood.

Several other species produced unusual partial second broods. I recorded six *Semiothisa liturata* Clerck between 4th and 19th August, the earlier emergence having been last seen on 8th July. *Dypterygia scabriuscula* L. first visited the trap on 8th May, and there was an extended emergence with the highest numbers in mid-June; after which it tailed off gradually until 9th July. A wave of fresh specimens appeared from the 13th to 24th July, and thereafter odd ones every two or three nights until 23rd August. *Sterrha seriata* Schrank produced small specimens in the first week of September: this happens in most years here, but the second broods of *S. subsericeata* Haw. (four specimens, all very small, from 9th to 25th August), of *S. dimidiata* Hufn. (two on 14th and 25th August), and of *Scopula imitaria* Hübn. (three from 2nd to 12th September), were distinctly unusual. There were also apparently small second broods of *Apatele leporina* L. and *A. megacephala* F. here in the first week of August, and about the same time Mr. J. L. Messenger had an example of *A. alni* L. at Witley, further south in Surrey, where the first brood had been numerous in May. Of *Hadena cucubali* Fuessly, which is a rare moth at Ottershaw, I recorded one specimen on 31st May and two more on 30th July and 9th August: between these last dates I had seen all three species, *H. cucubali, H. bicruris* and *H. lepida* Esp., flying together in strong second broods on the coast of South Devon. Finally, one may note the curious records of *Thyatira batis* L.: 9th May (one), 7th/8th July (three), 18th August (one).

There were also a number of isolated examples of second broods of species in which this is very unusual or previously not recorded at all here. I had a fresh specimen of *Phragmatobia fuliginosa* L. on 14th September, of *Caradrina morpheus* Hufn. on 3rd October (Baron de Worms at Horsell had another on 6th), of *C. alsines* Brahm on 8th November, of *Ourapteryx sambucaria* L. a small

female on 9th October, and of *Cleora punctinalis* Scop. a splendid melanic male on 13th August: of this species there had been one melanic example among the 13 first brood specimens recorded between 25th May and 7th June. Finally, when Mr. J. L. Messenger and I were collecting in Durfold Woods on 3rd October, a small male *Comibaena pustulata* Hufn. came to our light, and we found another in his trap at Witley when we returned there later in the evening. 'South' mentions the occasional occurrence of a second emergence of this species, but I have never before come across it myself or heard of anyone who had.

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CTENOPHTHALMUS C. CONGENER ROTHSCHILD, 1907, (SIPHONAPTERA) IN MIDDLESEX

This flea has twice before been recorded from Great Britain by Mr. F. G. A. M. Smit (1953, *Entomologist*, **86**: 19-22; *tom. cit.*, p. 199-200) from the counties of Hertfordshire and Sussex. These gatherings were made from the normal host, the bank vole, *Clethrionomys glareolus*.

I am now able, through the kindness of the collector, Mr. R. A. Davis, to record the occurrence of this flea in Middlesex and from a new host, the water vole, *Arvicola terrestris*. For some time Mr. Davis has been sending me gatherings of fleas taken from this mammal, and in one tube containing specimens collected from a live water vole caught on the Freys River, Uxbridge, 10th July, 1959, he took four fleas, one female being of this species plus 1 ♂ 2 ♀♀ *Megabothris walkeri* (Rothschild). This latter flea is commonly found on rodents, particularly the voles and most especially on those inhabiting damp situations.

So far as I have been able to ascertain there are no previous records for *Arvicola* as a host for *C. c. congener*, but another subspecies, *C. c. buresi* Rosicky has been recorded from *Arvicola* in south-east Bulgaria (Rosicky, B., 1959, Vysledky zoologické expedice CSAV do Bulharska (Cást III), *Acta Acad. Sc. Cechoslov. Basis Brunensis*, **31**: 321-354). The scarcity of records for this flea are no doubt due to a combination of factors the most important of which are probably that it has a very localized distribution pattern even though it is known from a large proportion of Europe, and the very small amount of interest taken in the siphonaptera. I am confident that further collecting in the east and south of Great Britain will considerably expand our knowledge of its distribution. In particular examination of water vole nests may be of interest, especially as nests of this host are very rarely searched for their fleas.

I am very grateful to Mr. Davis for sending the specimen to me, and to Mr. F. G. A. M. Smit for confirming my identification.

R. S. GEORGE, F.L.S., F.R.E.S.

SOUTH WESTMORLAND IN 1959

By THE REVEREND J. H. VINE HALL, B.D., A.K.C.

The year 1959 was notable here, as elsewhere, for the prolonged and glorious summer. Indeed, even well into October it looked as if the summer was never going to end! But it was not a notable year for Lepidoptera—or most other insects for that matter. Midges were extremely abundant in the calm and mild autumn and appeared in prodigious clouds from time to time, but wasps were uncommon, and one suspects that if it had been possible to make an accurate comparison it would have been found that the majority of insects were at a similar low level. At least that was the unmistakable impression. But we are concerned here with the Lepidoptera.

Migrants were scarce, and only a few *Vanessa atalanta* L. appeared here. No *Vanessa cardui* L. were seen at all. *Plusia gamma* L. and *Nomophila noctuella* Schiff. became common in the autumn—the only migrants to do so. The only interesting occurrence among the migrants was the capture of two specimens of *Laphygma exigua* Hübn. in the mercury vapour trap—one on 25th September and the other on 14th October. Among the residents it was noticeable too that the majority of species were in small numbers. One could see that clearly in the case of the butterflies, for the weather made observation of them an easy matter. The only really common butterflies were the local specialities which occur in strictly defined colonies, such as *Erebia epiphron* Knoch, *Erebia aethiops* Esp., *Coenonympha tullia* Müll. and our local race of *Aricia agestis* Schiff. They were all in very good numbers, but the species which range more widely were all very thin—they had suffered worse, one feels sure, through their natural habits, from the wild, wet and indifferent summers which had gone before, whereas the species which occur in dense colonies would have found it easier to discover mates and suitable plants for egg-laying in the brief fine periods and so would have been more efficiently preserved in spite of the weather. At least that is my theory, and it may be completely wrong. Genuine observation of the moth population is of course much harder, but the local day-flying moth, which is strictly colonial like the above-mentioned butterflies, *Phothedes captiuncula* Treits., was very common. The catches in the mercury vapour trap were, however, almost all on the poor side. How far this was due to genuinely thin numbers and how far to poor flying conditions at night it is hard to say, for a good deal of mystery still surrounds the problem of what really constitutes the condition for a 'good night'. The very fine weather of last summer may well have been far less advantageous to night fliers than to day fliers. This may partly account for the fact that catches last year were not noteworthy. I strongly suspect, though, that numbers were genuinely low as well. Anyhow, I recorded 229 species of Macro-

Heterocera, all but half a dozen or so being recorded from the trap. Three species not recorded here before appeared—one *Naenia typica* L. on 5th July—a species common only a very few miles away and quite unaccountably unseen here before—one *Apamea ophiogramma* Esp. on 18th July—a species more closely associated with lower ground, as at Kendal and along the Kent estuary—and three *Hydraecia crinanensis* Burr, one on 11th August and two on 8th September—a species which occurs in rather small numbers all round and which I had fully expected to take here some day. These three specimens have been checked by examination of the genitalia, and it appears that there is also a previous record for 18th September, 1956—a specimen which had been placed among the series of *H. oculea* L.

We are of course all wondering what noticeable effect, if any, the wonderful summer of 1959 will have on the insect population in 1960. By the time these notes appear in print the answer may be clear, but at the moment one guess is as good as another. There is no harm, however, in entertaining high hopes!

Hutton Roof Vicarage,
Westmorland.

REVISED INDEXED CHECK-LIST OF THE BRITISH LEPIDOPTERA

by I. R. P. HESLOP, M.A.

PART I

(*Continued from* p. 66)

Super-family **GEOMETROIDEA**

GEOMETRIDAE

ARCHIEARINAE

*667 **Archiearis parthenias** L.
Common Orange-underwing

668 **Archiearis notha** Hübn.
Light Orange-underwing

OENOCHROMINAE

*669 **Alsophila aescularia** Schiff.
March Usher

GEOMETRINAE

*670 **Aplasta ononaria** Fuessl.
Rest-harrow Guest

*671 **Pseudoterpna pruinata** Hufn.
(*cytisaria* Schiff.)
Greater Grass Emerald

*672 **Geometra papilionaria** L.
Large Emerald

*673 **Comibaena pustulata** Hufn.
(*bajularia* Schiff.)
Blotched Emerald

*674 **Hemithea aestivaria** Hübn.
(*strigata* Müll.)
Common Emerald

*675 **Chlorissa viridata** L.
Small Grass Emerald

676 **Chlorissa cloraria** Hübn.
(*porrinata* Zell.)
Hodgkinson's Emerald

*677 **Thetidia smaragdaria** F.
Essex Emerald

*678 **Thalera fimbrialis** Scop.
(*thymiaria* L.)
Sussex Emerald

*679 **Hemistola immaculata** Thunb.
(*chrysoprasaria* Esp.)
Lesser Emerald

*680 **Jodis lactearia** L.
Little Emerald

STERRHINAE

*681 **Calothysanis amata** L.
Large Blood-vein

*682 **Cosymbia albipunctata** Hufn.
(*pendularia* auct.)
Birch Mocha

683 **Cosymbia pendularia** Clerck
(*orbicularia* Hübn.)
Dingy Mocha

684 **Cosymbia annulata** Schulzens
(*omicronaria* Schiff.)
Maple Mocha

685 **Cosymbia puppillaria** Hübn.
Blair's Mocha

686 **Cosymbia porata** L.
False Mocha

687 **Cosymbia punctaria** L.
Maiden's Blush

688 **Cosymbia linearia** Hübn.
(*trilinearia* Borkh.)
Clay Triple-lines

*689 **Scopula ternata** Schrank
(*fumata* Steph.)
Smoky Wave

690 **Scopula immorata** L.
Lewes Wave

691 **Scopula rubiginata** Hufn.
(*rubricata* Schiff.)
Tawny Wave

692 **Scopula promutata** Guen.
(*marginepunctata* auct.)
Mullein Wave

693 **Scopula ornata** Scop.
(*paludata* L.)
Lace-border Wave

694 **Scopula imitaria** Hübn.
Small Blood-veined Wave

695 **Scopula emutaria** Hübn.
Rosy Wave

696 **Scopula nigropunctata** Hufn.
(*strigilaria* Hübn.)
Subangled Wave

697 **Scopula virgulata** Schiff.
(*strigaria* Hübn.)
Streaked Wave

698 **Scopula immutata** L.
Lesser Cream Wave

699 **Scopula lactata** Haw.
(*remutaria* Hübn.)
Greater Cream Wave

*700 **Sterrha ochrata** Scop.
(*ochrearia* Hübn.)
Pale Ochraceous Wave

701 **Sterrha vulpinaria** H.-S.
(*rusticata* auct.)
Least Carpeted Wave

702 **Sterrha interjectaria** Boisd.
(*fuscovenosa* auct.)
Dwarf Cream Wave

703 **Sterrha humiliata** Hufn.
(*osseata* Schiff.)
Isle of Wight Wave

704 **Sterrha dilutaria** Hübn.
(*holosericata* Dup.)
Silky Wave

705 **Sterrha serpentata** Hufn.
(*perochraria* F.R.)
Surrey Bright Wave

706 **Sterrha muricata** Hufn.
(*auroraria* Borkh.)
Purple-bordered Wave

707 **Sterrha dimidiata** Hufn.
(*scutulata* Schiff.)
Single-dotted Wave

708 **Sterrha eburnata** Wocke
(*contiguaria* Hübn.)
Weaver's Wave

709 **Sterrha inquinata** Scop.
(*herbariata* F.)
Rusty Wave

710 **Sterrha seriata** Schrank
(*virgularia* Hübn.)
Small Dusty Wave

711 **Sterrha subsericeata** Haw.
Satin Wave

712 **Sterrha sylvestraria** Hübn.
(*straminata* Treits.)
Ringed Wave

713 **Sterrha circellata** Guen.
Obscure Wave

714 **Sterrha laevigata** Scop.
Strange Wave

715 **Sterrha degeneraria** Hübn.
Portland Ribbon Wave

716 **Sterrha straminata** Borkh.
(*inornata* Haw.)
Plain Wave

717 **Sterrha aversata** L.
Riband Wave

718 **Sterrha trigeminata** Haw.
(*scutularia* Hübn.)
Treble-spot Wave

719 **Sterrha biselata** Hufn.
(*bisetata* Rott.)
Small Fan-footed Wave

720 **Sterrha emarginata** L.
Small Scallop Wave

*721 **Rhodometra sacraria** L.
Vestal

LARENTIINAE

*722 **Lythria purpuraria** L.
Purple-barred Yellow Carpet

*723 **Xanthorhoe quadrifasiata** Clerck
(*quadrifasciaria* L.)
Large Twin-spot Carpet

724 **Xanthorhoe munitata** Hübn.
Red Northern Carpet

725 **Xanthorhoe ferrugata** Clerck
(*unidentaria* Haw.)
Dark Twin-spot Carpet

726 **Xanthorhoe spadicearia** Schiff.
(*ferrugata* Staud., *non* Clerck)
Red Twin-spot Carpet

727 **Xanthorhoe biriviata** Borkh.
(*pomoeriaria* Ev.)
Balsam Carpet

728 **Xanthorhoe designata** Hufn.
(*propugnata* Schiff.)
Flame Carpet

729 **Xanthorhoe montanata** Schiff.
Silver-ground Carpet

730 **Xanthorhoe fluctuata** L.
Garden Carpet

*731 **Nycterosea obstipata** F.
(*fluviata* Hübn.)
Narrow-barred Carpet

*732 **Colostygia olivata** Schiff.
Beech-green Carpet

733 **Colostygia pectinataria** Knoch
(*viridaria* F.)
Spring Green Carpet

734 **Colostygia salicata** Hübn.
Striped Twin-spot Carpet

735 **Colostygia multistrigaria** Haw.
Grey Mottled Carpet

736 **Colostygia didymata** L.
Small Twin-spot Carpet

*737 **Pareulype berberata** Schiff.
Barberry Carpet

*738 **Earophila badiata** Schiff.
Shoulder-striped Carpet

*739 **Anticlea derivata** Schiff.
(*nigrofasciaria* auct.)
Streamer Carpet

*740 **Mesoleuca albicillata** L.
Beautiful Carpet

*741 **Entephria caesiata** Schiff.
Grey Mountain Carpet

742 **Entephria flavicinctata** Hübn.
Yellow-ringed Carpet

*743 **Perizoma sagittata** F.
Marsh Carpet

744 **Perizoma blandiata** Schiff.
(*adaequata* Borkh.)
Pretty-pinion Rivulet

745 **Perizoma taeniata** Steph.
Barred Carpet

746 **Perizoma affinitata** Steph.
Large Rivulet

747 **Perizoma alchemillata** L.
(*rivulata* Schiff.)
Small Rivulet

748 **Perizoma flavofasciata** Thunb.
(*decolorata* Hübn.)
Sandy Carpet

749 **Perizoma albulata** Schiff.
Grass Rivulet

750 **Perizoma bifaciata** Haw.
(*unifasciata* Haw.)
Barred Rivulet

751 **Perizoma minorata** Treits.
Heath Rivulet

*752 **Euphyia unangulata** Haw.
Sharp-angled Carpet

753 **Euphyia luctuata** Schiff.
(*lugubrata* Staud.)
White-banded Carpet

754 **Euphyia picata** Hübn.
Cloaked Carpet

755 **Euphyia cuculata** Hufn.
(*sinuata* Schiff.)
Royal Mantle

756 **Euphyia rubidata Schiff.**
Ruddy Carpet

757 **Euphyia polygrammata Borkh.**
Many-lined

758 **Euphyia bilineata L.**
Yellow Shell

*759 **Melanthia procellata Schiff.**
Pretty Chalk Carpet

*760 **Mesotype virgata Hufn.**
(*lineolata* Schiff.)
Oblique-striped

*761 **Lyncometra ocellata L.**
Purple Bar Carpet

*762 **Lampropteryx suffumata Schiff.**
Water Carpet

763 **Lampropteryx otregiata Metc.**
Metcalfe's Carpet

*764 **Electrophaes corylata Thunb.**
Broken-barred Carpet

*765 **Ecliptopera silaceata Schiff.**
Small Phoenix

*766 **Eustroma reticulata Schiff.**
Netted Carpet

*767 **Lygris prunata L.**
Large Phoenix

768 **Lygris testata L.**
Common Chevron

769 **Lygris populata L.**
Northern Spinach

770 **Lygris mellinata F.**
(*associata* Borkh.)
Currant Spinach

771 **Lygris pyraliata Schiff.**
(*dotata* L.)
Barred Straw Chevron

*772 **Cidaria fulvata Forst.**
Barred Yellow

*773 **Plemyria rubiginata Schiff.**
(*bicolorata* Hufn.)
Blue-bordered Carpet

*774 **Chloroclysta siterata Hufn.**
(*psittacata* Hübn.)
Red-green Carpet

775 **Chloroclysta miata L.**
Autumn Green Carpet

*776 **Dysstroma truncata Hufn.**
(*russata* Borkh.)
Common Marbled Carpet

777 **Dysstroma concinnata Steph.**
Arran Marbled Carpet

778 **Dysstroma citrata L.**
(*immanata* Haw.)
Dark Marbled Carpet

*779 **Thera obeliscata Hübn.**
Grey Pine Carpet

780 **Thera variata Schiff.**
Grey Spruce Carpet

781 **Thera cognata Thunb.**
(*simulata* Hübn.)
Chestnut-coloured Carpet

782 **Thera firmata Hübn.**
Reddish Pine Carpet

783 **Thera juniperata L.**
Juniper Carpet

*784 **Hydriomena furcata Thunb.**
(*sordidata* F.)
July Highflyer

785 **Hydriomena coerulata F.**
(*impluviata* Schiff.)
May Highflyer

786 **Hydriomena ruberata Freyer**
Ruddy Highflyer

*787 **Philereme vetulata Schiff.**
Brown Scallop

788 **Philereme transversata Hufn.**
(*rhamnata* Schiff.)
Dark Scallop

*789 **Triphosa dubitata L.**
Common Tissue

*790 **Rheumaptera cervinalis Scop.**
(*certata* Hübn.)
Scarce Tissue

791 **Rheumaptera undulata L.**
Shell Scallop

792 **Rheumaptera hastata L.**
Large Argent-and-sable

793 **Rheumaptera subhastata** Nolck.
Northern Mottled Carpet

*794 **Epirrhoe rivata** Hübn.
Wood Carpet

795 **Epirrhoe alternata Müll.**
(*sociata* Borkh.)
Common Bedstraw Carpet

796 **Epirrhoe tristata L.**
Small Argent-and-sable

797 **Epirrhoe galiata Schiff.**
Galium Carpet

*798 **Lithostege farinata Hufn.**
(*nivearia* Hübn.)
Snowy Carpet

799 **Lithostege griseata Schiff.**
Pale Grey Carpet

*800 **Chesias legatella Schiff.**
(*spartiata* Fuessl.)
Streaked Carpet

801 **Chesias rufata F.**
(*obliquaria* Schiff.)
Broom-tip Chevron

*802 **Odezia atrata L.**
(*chaerophyllata* L.)
Chimney-sweeper

*803 **Anaitis plagiata L.**
Slender Treble-bar

804 **Anaitis efformata Guen.**
Short-clasped Treble-bar

*805 **Carsia sororiata** Hübn.
(*paludata* Thunb.)
Manchester Treble-bar

*806 **Coenocalpe lapidata** Hübn.
Slender-striped Rufous

*807 **Horisme vitalbata Schiff.**
Umber Waved Carpet

808 **Horisme aquata** Hübn.
Cumbrian Carpet

809 **Horisme tersata Schiff.**
Fern Carpet

*810 **Lobophora halterata Hufn.**
(*hexapterata* Schiff.)
Large Seraphim

*811 **Mysticoptera sexalata Retz.**
(*sexalisata* Hübn.)
Small Seraphim

*812 **Acasis viretata** Hübn.
Brindle-barred Yellow

*813 **Trichopteryx polycommata** Schiff.
Barred Tooth-striped

814 **Trichopteryx carpinata Borkh.**
(*lobulata* Hübn.)
Early Tooth-striped

*815 **Orthonama lignata Hübn.**
(*vittata* Borkh.)
Oblique Carpet

*816 **Ortholitha mucronata Scop.**
(*umbrifera* Prout)
Common Lead-belle

817 **Ortholitha plumbaria F.**
(*umbrifera* auct.)
July Lead-belle

818 **Ortholitha chenopodiata L.**
(*limitata* Scop.)
Shaded Broad-bar

819 **Ortholitha moeniata Scop.**
Fortified Carpet

820 **Ortholitha peribolata Hübn.**
Spanish Carpet

821 **Ortholitha bipunctaria Schiff.**
Local Chalk Carpet

*822 **Larentia clavaria Haw.**
(*cervinata* Schiff.)
Mallow Carpet

*823 **Pelurga comitata L.**
Dark Spinach

*824 **Oporinia autumnata Borkh.**
Large Autumnal Carpet

825 **Oporinia filigrammaria H.-S.**
Small Autumnal Carpet

826 **Oporinia dilutata** Schiff.
(*nebulata* Thunb. *non* Scop.)
November Carpet

827 **Oporinia christyi** Prout
Christy's Carpet

*828 **Operophtera brumata** L.
Common Winter

829 **Operophtera fagata** Scharf.
(*boreata* Hübn.)
Northern Winter

*830 **Asthena albulata** Hufn.
(*candidata* Schiff.)
White Waved Carpet

*831 **Minoa murinata** Scop.
(*euphorbiata* Schiff.)
Drab Carpet

*832 **Hydrelia flammeolaria** Hufn.
(*luteata* Schiff.)
Yellow Waved Carpet

833 **Hydrelia testaceata** Don.
(*sylvata* Schiff.)
Sylvan Waved Carpet

*834 **Euchoeca nebulata** Scop.
(*obliterata* Hufn.)
Dingy Shell

*835 **Venusia cambrica** Curt.
Welsh Waved Carpet

*836 **Discoloxia blomeri** Curt.
Blomer's Ripplet

*837 **Anticollix sparsata** Treits.
(*sparsaria* Hübn.)
Dentated Pug

*838 **Eupithecia pini** Retz.
(*togata* Hübn.)
Cloaked Pug

839 **Eupithecia subumbrata** Schiff.
(*scabiosata* Borkh.)
Shaded Pug

840 **Eupithecia subnotata** Hübn.
Plain Pug

841 **Eupithecia millefoliata** Rössl.
Milfoil Pug

842 **Eupithecia distinctaria** H.-S.
Thyme Pug

843 **Eupithecia tenuiata** Hübn.
Slender Pug

844 **Eupithecia inturbata** Hübn.
(*subciliata* Doubl.)
Maple Pug

845 **Eupithecia haworthiata** Doubl.
(*isogrammaria* H.-S.)
Haworth's Pug

846 **Eupithecia plumbeolata** Haw.
Lead-coloured Pug

847 **Eupithecia linariata** Schiff.
Toadflax Pug

848 **Eupithecia pulchellata** Steph.
Foxglove Pug

849 **Eupithecia irriguata** Hübn.
Marbled Pug

850 **Eupithecia exiguata** Hübn.
Mottled Pug

851 **Eupithecia insigniata** Hübn.
(*consignata* Borkh.)
Pinion-spotted Pug

852 **Eupithecia valerianata** Hübn.
Valerian Pug

853 **Eupithecia pygmaeata** Hübn.
(*palustraria* Doubl.)
Marsh Pug

854 **Eupithecia venosata** F.
Netted Pug

855 **Eupithecia centaureata** Schiff.
(*oblongata* Thunb.)
Lime-speck Pug

856 **Eupithecia trisignaria** H.-S.
Triple-spotted Pug

857 **Eupithecia intricata** Zett.
(*helveticaria* Boisd.)
Edinburgh Pug

858 **Eupithecia satyrata** Hübn.
Satyr Pug

859 **Eupithecia tripunctaria** H.-S.
(*albipunctata* Haw. *non* Hufn.)
White-spotted Pug

860 **Eupithecia absinthiata** Clerck
(*minutata* Schiff.)
Wormwood Pug

861 **Eupithecia goossensiata** Mab.
(*minutata* Doubl. *non* Schiff.)
Ling Pug

862 **Eupithecia expallidata** Doubl.
Bleached Pug

863 **Eupithecia assimilata** Doubl.
Currant Pug

864 **Eupithecia vulgata** Haw.
Common Pug

865 **Eupithecia denotata** Hübn.
(*campanulata* H.-S.)
Bell-flower Pug

866 **Eupithecia castigata** Hübn.
Grey Pug

867 **Eupithecia icterata** Vill.
Tawny Speckled Pug

868 **Eupithecia succenturiata** L.
Bordered Pug

869 **Eupithecia indigata** Hübn.
Ochreous Pug

870 **Eupithecia pimpinellata** Hübn.
(*denotata* Guen.)
Pimpinel Pug

871 **Eupithecia extensaria** Freyer
Scarce Pug

872 **Eupithecia nanata** Hübn.
Narrow-winged Pug

873 **Eupithecia innotata** Hufn.
Angle-barred Pug

874 **Eupithecia fraxinata** Crewe
Ash Pug

875 **Eupithecia tamarisciata** Freyer
Cornish Tamarisk Pug

876 **Eupithecia virgaureata** Doubl.
Goldenrod Pug

877 **Eupithecia abbreviata** Steph.
Brindled Pug

878 **Eupithecia dodoneata** Guen.
Oak-tree Pug

879 **Eupithecia phoeniciata** Ramb.
Black-streaked Pug

880 **Eupithecia sobrinata** Hübn.
(*pusillata* auct.)
Juniper Pug

881 **Eupithecia anglicata** H.-S.
(*stevensata* Webb)
Kentish Tamarisk Pug

882 **Eupithecia lariciata** Freyer
Larch Pug

883 **Eupithecia tantillaria** Boisd.
(*pusillata* Schiff.)
Dwarf Pug

*884 **Chloroclystis coronata** Hübn.
V Pug

885 **Chloroclystis debiliata** Hübn.
Bilberry Pug

886 **Chloroclystis rectangulata** L.
Green Pug

*887 **Gymnoscelis pumilata** Hübn.
Double-striped Pug

DEILINIINAE

*888 **Abraxas sylvata** Scop.
(*ulmata* F.)
Clouded Magpie

889 **Abraxas grossulariata** L.
Common Magpie

890 **Abraxas pantaria** L.
Light Magpie

*891 **Lomaspilis marginata** L.
Clouded Border

*892 **Ligdia adustata** Schiff.
Scorched Silver

*893 **Bapta distinctata** H.-S.
(*pictaria* Curt.)
Carpet Thorn

894 **Bapta bimaculata** F.
(*taminata* Schiff.)
White-pinion Spotted

895 **Bapta temerata** Schiff.
(*punctata* Hübn.)
Clouded Silver

*896 **Deilinia pusaria** L.
White Waved Silver

897 **Deilinia exanthemata** Scop.
Common Waved Silver

*898 **Ellopia fasciaria** L.
(*prosapiaria* L.)
Barred Red

*899 **Campaea margaritata** L.
(*margaritaria* L.)
Barred Light-green

*900 **Angerona prunaria** L.
Orange Thorn

*901 **Semiothisa notata** L.
Blunt Peacock Angle

902 **Semiothisa alternaria** Hübn.
(*alternata* Schiff.)
Sharp Peacock Angle

903 **Semiothisa liturata** Clerck
Tawny-barred Angle

*904 **Theria rupicapraria** Schiff.
Early Umber

*905 **Erannis leucophaearia** Schiff.
Spring Umber

906 **Erannis aurantiaria** Hübn.
Scarce Umber

907 **Erannis marginaria** F.
(*progemmaria* Hübn.)
Dotted Border

908 **Erannis defoliaria** Clerck
Mottled Umber

ENNOMINAE

*909 **Anagoga pulveraria** L.
Barred Umber Thorn

*910 **Ennomos autumnaria** Wernb.
(*alniaria* Schiff. *non* L.)
Large Thorn

911 **Ennomos quercinaria** Hufn.
(*angularia* Hübn.)
August Thorn

*912 **Deuteronomos alniaria** L.
(*tiliaria* Borkh.)
Canary-shouldered Thorn

913 **Deuteronomos fuscantaria** Steph.
Dusky Thorn

914 **Deuteronomos erosaria** Schiff.
September Thorn

*915 **Selenia bilunaria** Esp.
(*illunaria* Hübn.)
Early Thorn

916 **Selenia lunaria** Schiff.
Lunar Thorn

917 **Selenia tetralunaria** Hufn.
(*illustraria* Hübn.)
Purple Thorn

*918 **Apeira syringaria** L.
Lilac Thorn

*919 **Gonodontis bidentata** Clerck
Scalloped Hazel Thorn

*920 **Colotois pennaria** L.
Feathered Thorn

*921 **Crocallis elinguaria** L.
Scalloped Oak Thorn

*922 **Plagodis dolabraria** L.
Scorched-wing

*923 **Opisthograptis luteolata** L.
(*crataegata* L.)
Sulphur Thorn

*924 **Epione repandaria** Hufn.
(*apiciaria* Schiff.)
Common Bordered-beauty

925 **Epione vespertaria** L.
(*parallelaria* Schiff.)
Dark Bordered-beauty

*926 **Cepphis advenaria** Hübn.
Little Thorn

*927 **Pseudopanthera macularia** L.
Speckled Yellow

OURAPTERYGINAE

*928 **Ourapteryx sambucaria** L.
Swallow-tailed Elder

BISTONINAE

*929 **Phigalia pedaria** F.
(*pilosaria* Schiff.)
Pale Brindled-beauty

*930 **Apocheima hispidaria** Schiff.
Small Brindled-beauty

*931 **Poecilopsis lapponaria** Boisd.
Rannoch Brindled-beauty

*932 **Nyssia zonaria** Schiff.
Belted Brindled-beauty

*933 **Lycia hirtaria** Clerck
London Brindled-beauty

*934 **Biston strataria** Hufn.
(*prodromaria* Schiff.)
Oak Brindled-beauty

935 **Biston betularia** L.
Pepper-and-salt

BOARMIINAE

*936 **Menophra abruptaria** Thunb.
Waved Umber Beauty

*937 **Cleora cinctaria** Schiff.
Ringed Beauty

938 **Cleora rhomboidaria** Schiff.
(*gemmaria* Brahm)
Willow Beauty

*939 **Cleorodes lichenaria** Hufn.
Brussels Lace

*940 **Deileptenia ribeata** Clerck
(*abietaria* Schiff.)
Satin Beauty

*941 **Alcis repandata** L.
Mottled Beauty

942 **Alcis arenaria** Hufn.
(*angularia* Thunb.)
Speckled Beauty

943 **Alcis jubata** Thunb.
(*glabraria* Schiff.)
Dotted Beauty

*944 **Boarmia roboraria** Schiff.
Great Oak Beauty

*945 **Pseudoboarmia punctinalis** Scop.
(*consortaria* F.)
Pale Oak Beauty

*946 **Ectropis biundularia** Borkh.
(*bistortata* auct.)
Early Engrailed

947 **Ectropis crepuscularia** Schiff.
(*biundularia* Esp.)
Small Engrailed

948 **Ectropis consonaria** Hübn.
Square-spot Beauty

949 **Ectropis extersaria** Hübn.
(*luridata* Borkh.)
Brindled White-spot

*950 **Aethalura punctulata** Schiff.
(*punctularia* Hübn.)
Grey Birch Beauty

*951 **Tephronia cremiaria** Freyer
(*sepiaria* auct. *non* Hufn.)
Dusky Carpet Beauty

*952 **Pachycnemia hippocastanaria** Hübn.
Horse-chestnut Longwing

*953 **Gnophos obscurata** Schiff.
(*pullata* Staint.)
Common Annulet

954 **Gnophos obfuscata** Schiff.
(*myrtillata* Thunb.)
Scotch Annulet

*955 **Psolos coracina** Esp.
(*trepidata* Dup.)
Black Mountain

*956 **Isturgia carbonaria** Clerck
Netted Mountain

957 **Isturgia limbaria** F.
(*conspicuata* Schiff.)
Frosted Yellow

*958 **Ematurga atomaria** L.
Common Heath Beauty

*959 **Bupalus piniaria** L.
Bordered White Beauty

*960 **Selidosema brunnearia** Vill.
(*plumaria* auct.)
Bordered Grey Beauty

*961 **Itame wauaria** L.
V Looper

962 **Itame brunneata** Thunb.
(*fulvaria* Vill.)
Rannoch Looper

*963 **Lithina chlorosata** Scop.
(*petraria* Hübn.)
Brown Silver-lined

*964 **Chiasmia clathrata** L.
Heath Lattice

*965 **Dyscia fagaria** Thunb.
(*belgaria* Hübn.)
Grey Scalloped Bar

*966 **Idaea lineata** Scop.
(*dealbata* L.)
Black-veined Looper

*967 **Aspitates gilvaria** Schiff.
Straw Belle

968 **Aspitates ochrearia** Rossi
(*citraria* Hübn.)
Yellow Belle

*969 **Perconia strigillaria** Hübn.
Grass-waved

(Part I *concluded*)

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